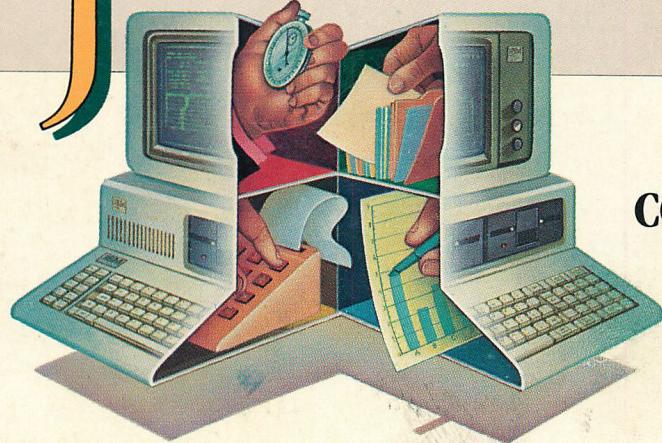


MARCH 1984

VOL. 1, NO. 6 \$3.95

FOR IBM PERSONAL COMPUTER USERS

# TECH JOURNAL



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*Multitasking for the PC*

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## GRAPHICS SUBROUTINES: A BOOK EXCERPT

## TECMAR'S LAB MASTER AND THE PC: LABORATORY EFFICIENCY

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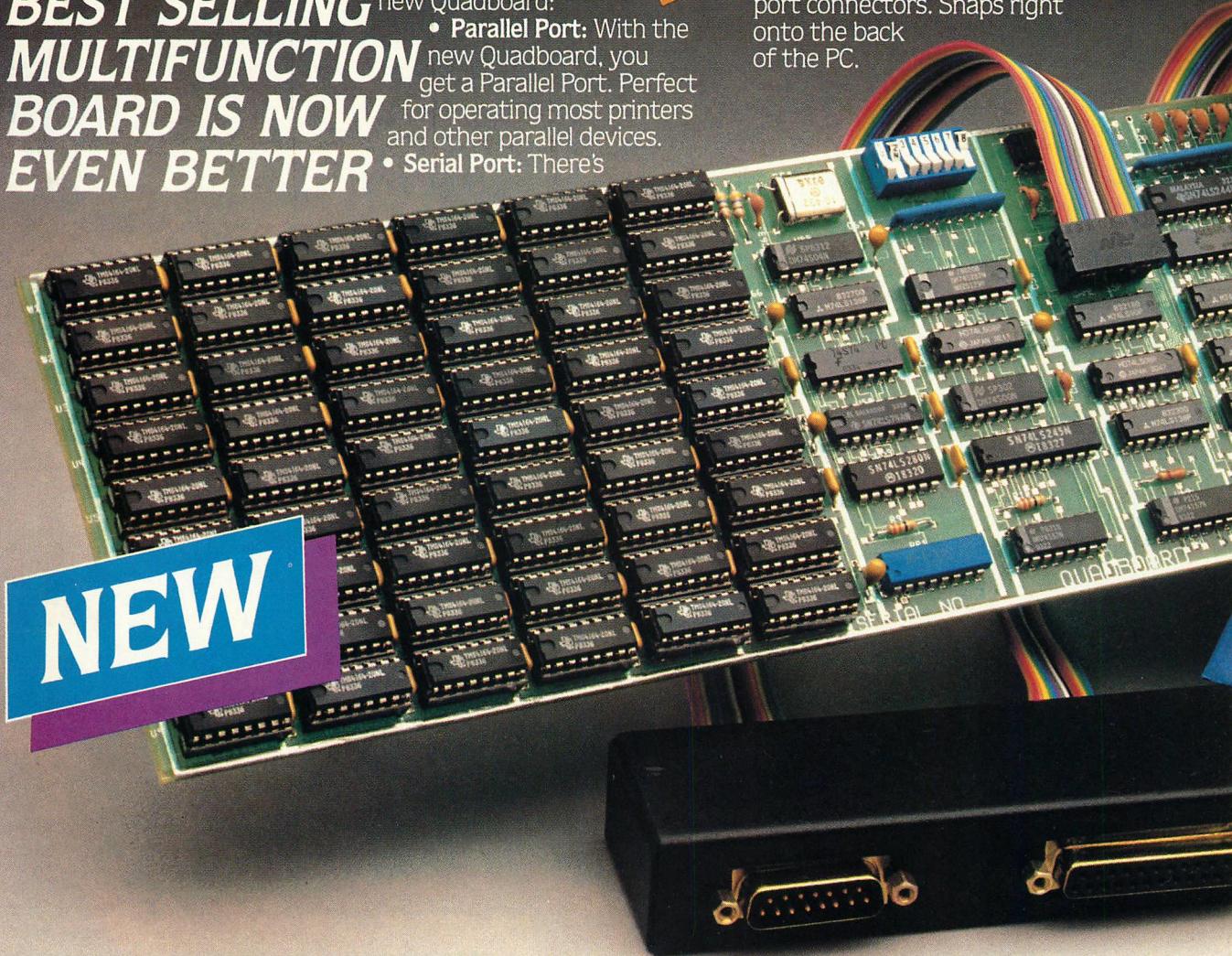
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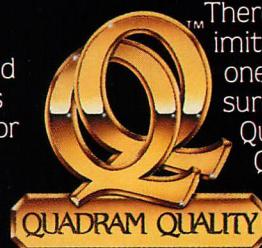
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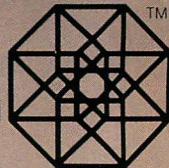
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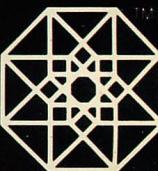
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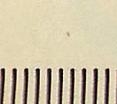
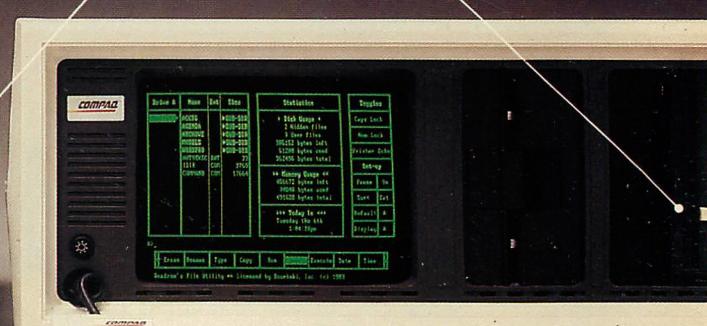
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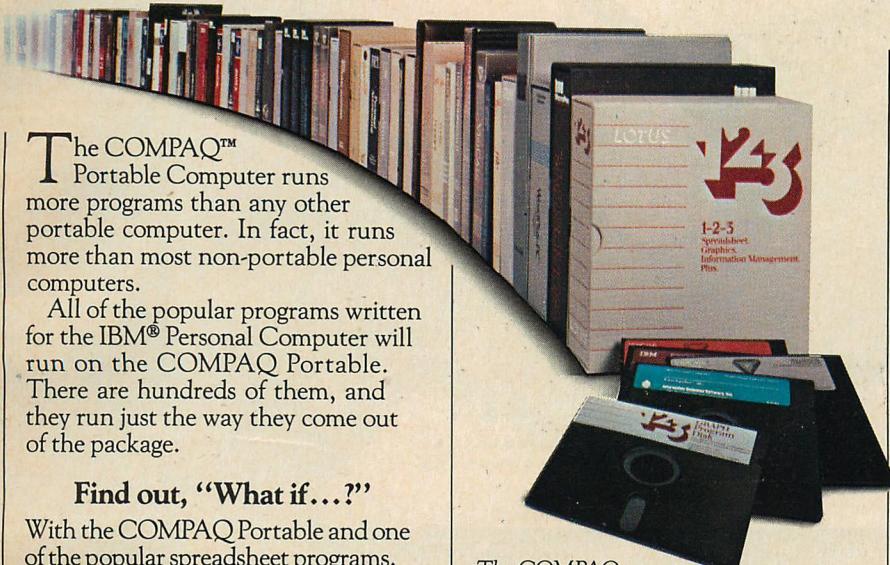


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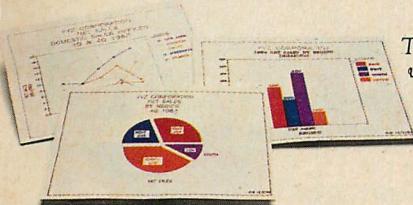
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# TECH JOURNAL

## ARTICLES

### PLOTTING, DRAWING, AND FILLING USING ASSEMBLY LANGUAGE SUBROUTINES

**CHRISTOPHER L. MORGAN** / Routines for fundamental plotting jobs on the PC color graphics screen. An excerpt from *Bluebook of Assembly Language Subroutines*

38

### CCP/M-86

**DON AWALT** / Digital Research's CCP/M-86 up close: its history, its architecture, and its advantages for the PC

64

### DAVONG'S MULTILINK: VERSATILITY AT A MODERATE PRICE

**SUSAN GLINERT-COLE** / Test results from a local area network that allows the PC to be both a shared station and a user station without a loss in performance

78

### DRAWING AND ANALYZING CIRCUITS WITH MICRO-CAP

**WILLIAM H. MURRAY** / An analog design program for electrical engineering work

88

### DIGITAL-TO-ANALOG, ANALOG-TO-DIGITAL

**PETER G. AITKEN** / A scientist puts Tecmar's Lab Master Board to the test

104

### LINKING ASSEMBLY SUBROUTINES TO BASIC PROGRAMS

**FREDERICK R. BRACK** / Getting the best of both worlds: a step-by-step guide

118

### GRAPHICS ON THE IBM MONOCHROME DISPLAY

**RAY DUNCAN** / A look at two products that enhance monochrome systems

142

### DISK DUPLICATION

**JOHN W. WORAM** / Diskette copying services: who they are, what they charge

154

### THE JENSEN JTK-16 ELECTRONIC TOOL KIT

**WILL FASTIE** / A tool kit for modern times

166

### VIDEO I/O AND GRAPHICS WITH IBM PASCAL

**BARBARA CLINGER** / Controlling video I/O using an undocumented function provided with the Pascal compiler

179

### DEPARTMENTS

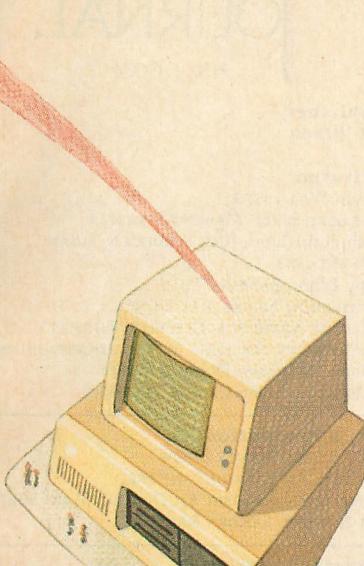
- Directions 11
- Letters 22
- Newsline 28
- Tech Releases 195
- Book Review 184
- Legal Brief 186
- Calendar 208

### TECH NOTEBOOK

- 14: Defining Function
- Keys Using
- ANSI.SYS 77

### PRODUCTS

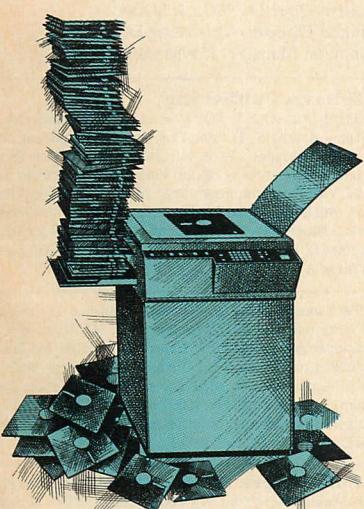
- Index to
- Advertisers 207
- Product Index 206
- Tech Book 201
- Tech Mart 205



78



154



118

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VOL. 1, NO. 6

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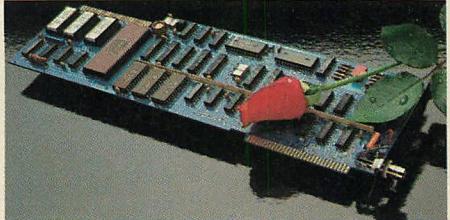
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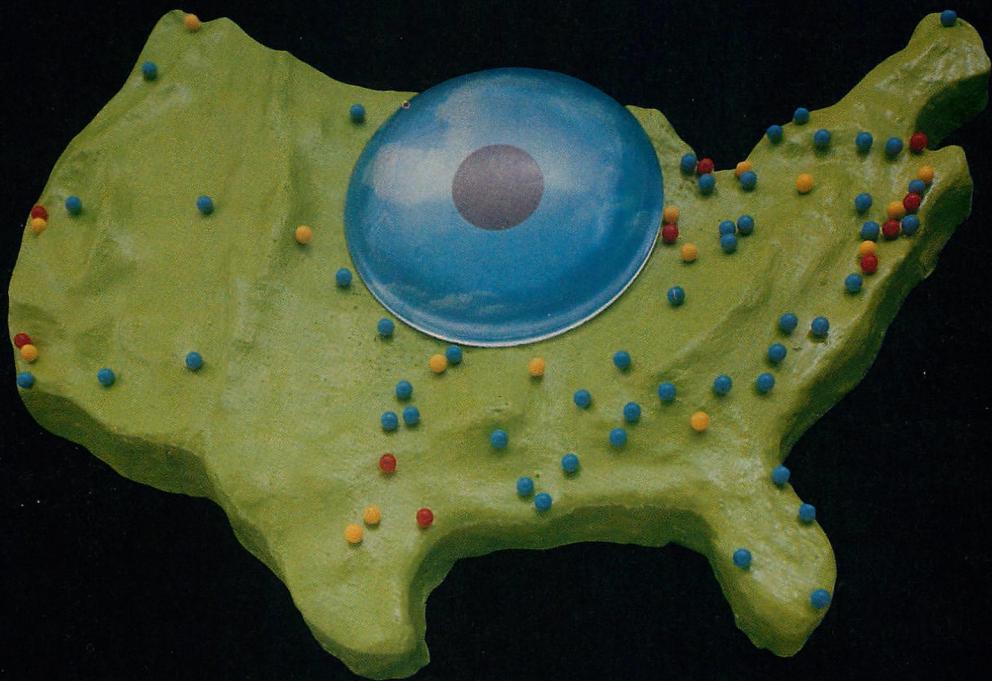


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5. **QUARTZ CLOCK/CALENDAR**
6. **MEMORY** - 64K to 512K bytes
7. **TurboRAM** - Extra RAM used as hard disk.
8. **TurboSpool** - Print job buffer/spooler.
9. **TurboComm** - SuperSmart MODEM control program includes: Single key, built-in emulation of

such popular terminals as DEC VT-100 (ANSI standard), Data General 605X series, ACT-5A and ADM-5A. Supports all standard baud rates to 19,200. Single keystroke connection to host. Screen transmission status reporting. Full printer and disc drive controls. Full buffering and interrupt driven I/O. Error detection and logging. Capability to interactively download and upload disk files.

10. **TurboFile** - TurboComm's file transfer utility featuring: Automatic unattended file transfer initiated any time, day or night. Transfers any file supported by PC/DOS. Automatic error detection and recovery. Password computer access protection.

## CHECK OUR STANDARD FEATURES AND LOW COST OPTIONS

	BASE PRICE	SUPERSMART MODEM	PARALLEL PORT	SERIAL PORT	MOUSE/ GAME PORT	CALENDAR/ CLOCK	64K BYTES MEMORY	AUTO DIALER	TURBO COMM	TURBO FILE	TURBO RAM	TURBO SPOOL
<b>MAGNUM MODEM</b>	595.	✓				✓	325.	75.	✓	✓	50.	50.
<b>MAGNUM MEMORY</b>	425.						✓				✓	✓
<b>MINI-MAGNUM</b>	695.	✓	✓	✓	✓	✓	325.	75.	✓	✓	50.	50.
<b>MAGNUM 10</b>	1195.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

ADD 75.00 PER EACH ADDITIONAL 64K OF MEMORY UP TO 512K BYTES

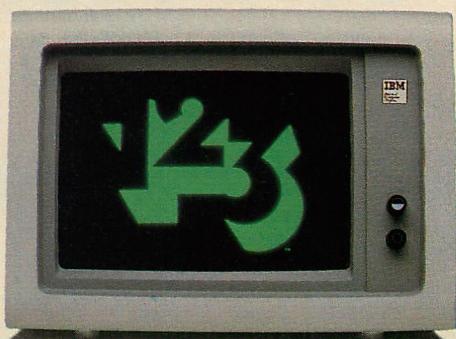
Order now! Check, M.O. Visa and Mastercard accepted • Satisfaction guaranteed. 2 years warranty

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ELEVEN-ONE-ELEVEN WILCREST GREEN DRIVE  
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**AMERICAN  
HIGH-TECH**

# HERCULES<sup>TM</sup> is the only graphics card that can run 1-2-3 on IBM's monochrome display.



## And that's just for starters.

You don't have a Hercules Graphics Card? Then unfortunately you won't be able to run 1-2-3, including all its graphics, on IBM's monochrome display. And you'll miss out on all the other reasons why there are more Hercules Graphics Cards producing more high resolution graphics than any other add-on card for the IBM PC.

But don't take just our word for it. If you need convincing, remember that most of the IBM PCs at Lotus<sup>TM</sup> are running Hercules Graphics Cards. And the authors of 1-2-3 know a good card when they see one. Or consider that the Hercules Graphics Card is widely used at Rockwell, Mass Mutual, and Carnegie Mellon. They couldn't all be wrong, could they?

At \$499, we think the Hercules Graphics Card offers the best price/performance ratio of any graphics card available today. As you can tell, plenty of users agree with us.

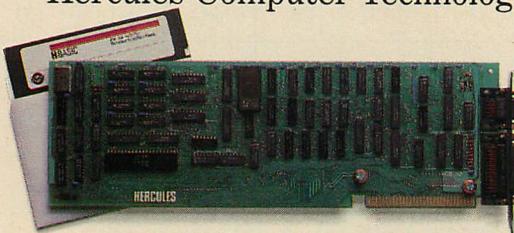
Call or write for our free information kit. You'll see why the first graphics card for the IBM PC is still the best. Hercules Computer Technology, 2550 Ninth St., Suite 210,

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Telephone: (415) 540-6000.

**Hercules. We're  
strong on graphics.**

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**CIRCLE NO. 151 ON READER SERVICE CARD**



The Hercules Graphics Card offers 720 x 348 graphics resolution on IBM's monochrome display, compatibility with text mode software, a parallel printer port, software to use BASIC's graphics and a two year warranty. A graphics subroutine library with screen dump is available separately for \$50. Graphics software that is compatible with the IBM color graphics card but does not have a Hercules compatible version will not run on the Hercules Graphics Card. **Foreign Distributors:** Reflex/U.K.; Computer 2000/W Germany; Edisoft/France. Hercules Graphics Card is a trademark of Hercules Computer Technology. IBM is a registered trademark of International Business Machines. 1-2-3 and Lotus are trademarks of Lotus Development.

## Directions

# Software Protection

*Software needs hardware's help*

## WILL FASTIE

There is probably no more controversial topic in computing today than the issue of software protection. This issue is made up of three related subjects, which I restate here for reference even though I am sure they are well known. One springs from the vendor of software and the two others from the owner/licensee (hereinafter simply called the *purchaser*).

First, the vendor desires to be paid for each copy of the software sold. Second, the purchaser desires at least one backup copy to protect against the very real possibility of diskette wear and subsequent loss of the program. Third, the purchaser also desires flexibility and ease of use, including the ability to run the program from hard disk or electronic disk. Let's examine each issue.

The vendor has every right to be paid the set price for each copy of a software product. This should not be a matter that is open to interpretation, providing the vendor has the

right to sell the product in the first place. Furthermore, the vendor has the right to set any terms upon the purchase that he desires, including restrictive covenants such as a requirement that the product be used on only one machine at a time. This concept is not alien to us; we regularly abide by similar restrictions on other goods, services, and licenses.

We seem to discard our normal view of this concept, however, when it comes to computer software. Although our actions may be clearly against the letter and intent of software agreements we have made, we seem to violate the terms to suit our own particular situation and convenience. We don't sneak around and hide our actions either: they are done in the light of day, without secrecy. Whatever our reasons or justifications, we are not all abiding by the terms of software agreements, and we are giving software vendors fits.

From our—the purchasers'—perspective, flexible magnetic media is not the most trustworthy storage media available. It is entirely reasonable

for us to expect the vendor to provide a mechanism that allows us to protect our expensive purchase and to guard against future loss of time. Second, it may not always be convenient or desirable to use the supplied media to execute the program. Hard disks are the obvious problem here; it is very convenient to be able to type the name of a program and have it execute right away, without fooling around with finding a specific diskette. Even the simple technique of letting the program check the master diskette and then allowing it to be removed is, frankly, annoying.

The real problem comes from untrustworthy users who want more flexibility than the vendor's protection schemes allow.

## THE CURRENT STATE OF AFFAIRS

To the purchasers' dismay, the solution most vendors seem to have adopted is copy-protecting diskettes. To accommodate hard disks and electronic disks, an increasing number of vendors are switching to the check-



# Textra<sup>TM</sup> word processing

The shortest distance between  
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Your thoughts come faster than your  
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CIRCLE NO. 228 ON READER SERVICE CARD



**A<sup>2</sup> Software**

Textra runs on the IBM PC and compatibles, and  
requires PCDOS (any version), 128K, and either  
monitor. Textra Jr. (\$39.95) requires 64K.

# Even your favorite software can have annoying personal habits. Get ProKey.



If you're like most of us you probably own an IBM PC and a closetful of popular software. Maybe Wordstar, Visicalc, dBase II and a few others. And with each program comes its own peculiar protocol, commands and demands.

Suddenly you've become a personal slave to your personal computer.

Free yourself with ProKey.™

ProKey is unlike any other software because it operates just about any other software. So you can spend your time creatively while ProKey takes care of the tedious operational details. Silently, instantly, without errors.

ProKey can print spreadsheet tables, update databases, reformat reports and plot graphics and still leave you time to train for the triathlon or run out for a danish.

In fact, ProKey can memorize and execute anything you can type.

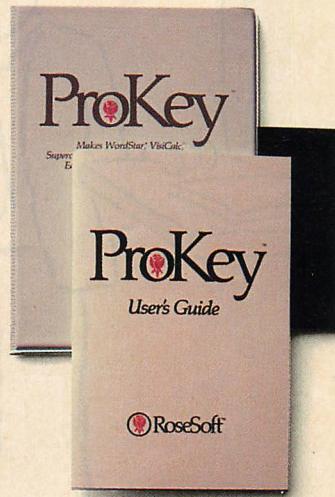
And no matter how extensive your software collection becomes ProKey controls them all, with one easy to remember protocol.

With all the time you save you'll be able to customize off-the-shelf software to your own personal or business requirements.

Ultimately you'll use ProKey as a "super-command center" operating your own software programs together to create a totally unique, incredibly creative system.

ProKey is available at most Computerland stores and wherever fine software is sold.

Once you use ProKey you'll never curse your cursor again.



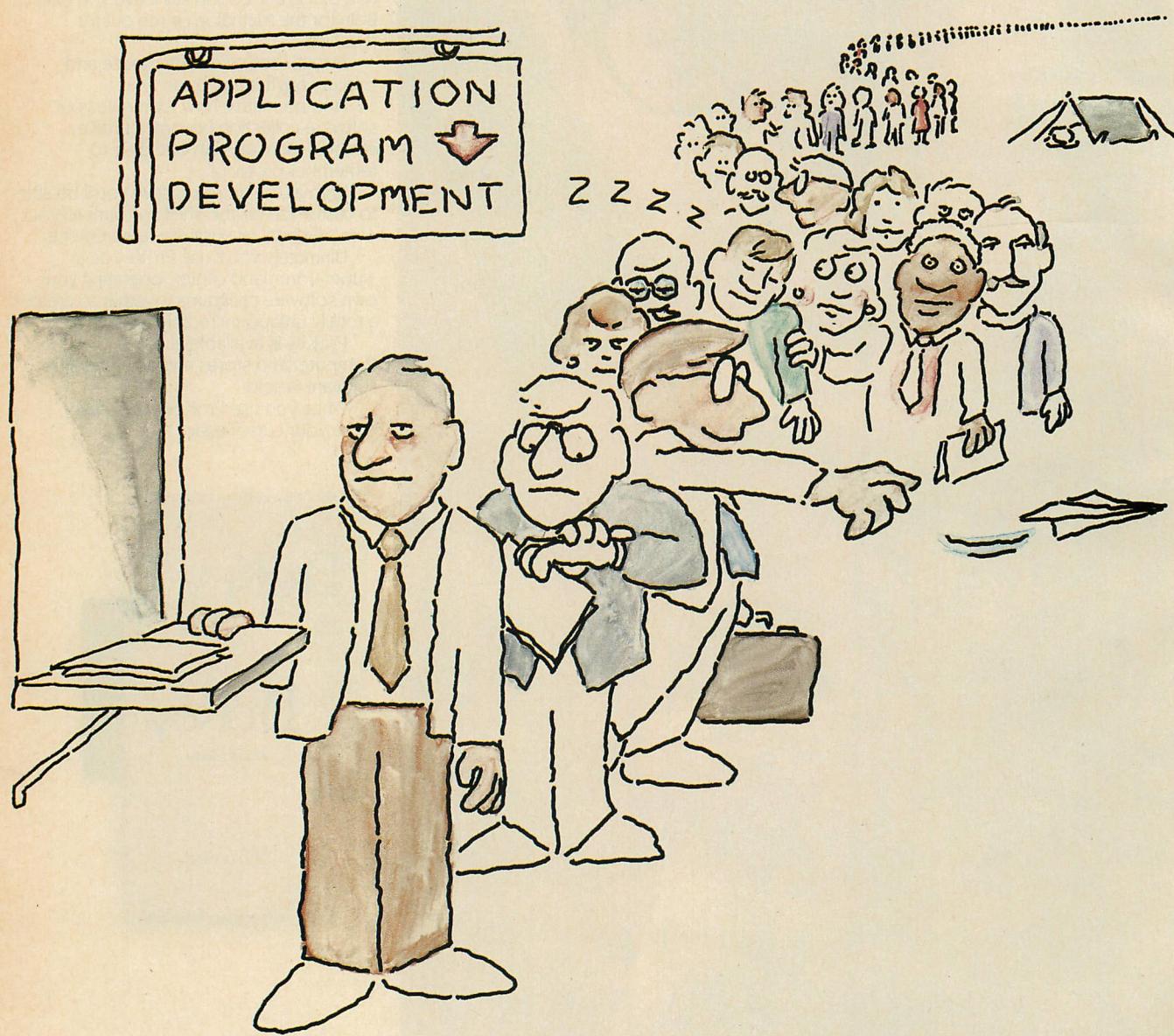
RoseSoft, Inc.  
4710 University Way, N.E.  
Suite 601,  
Seattle, WA 98105  
(206) 524-2350

To run ProKey, you'll need an IBM Personal Computer or workalike DOS (any version, including 2.0), and 64K of RAM (WordStar requires 96K).

WordStar, Visicalc and dBase II are trademarks, respectively, of Micro Pro, Visicorp and Ashton-Tate.

CIRCLE NO. 222 ON READER SERVICE CARD

# m3278/SPF puts micros on-line to mainfra



# Lines and cuts application software backlog.

A recent survey found that an average mainframe user would have to wait 3½ years for development work to begin on an application requested today.

That's a long time to wait.

In the same study, managers felt on-line programming offered the greatest potential for reducing the backlog.

It was their number one choice.

If on-line programming offers the greatest potential for cutting application program development backlog, what's the problem?

Simply this.

A limited number of programmers have mainframe access at any given time.

m3278/SPF™ can help.

Programmers on staff become more productive.

Productivity is substantially increased with m3278/SPF.

Why?

Because the programmers' workstation is not down while programs are compiling or downloading.

Coding continues without interruptions.

You may be able to eliminate application backlog without adding programmers. But, it is comforting to know programmers can be added without the expense of another host.

A substantial increase in the number of on-line programmers is possible with m3278/SPF.

The number of on-line programmers is doubled with m3278/SPF™ when only 40% of the programming effort is in Edit/Browse mode. But, when 90% of the effort is Edit/Browse, a whopping 7 to 1 increase of on-line programmers is realized.

With m3278/SPF™ IBM PC users are directly on-line with the host computer via direct (coax) link at channel transfer rates.

Including, uploading and downloading programs or datasets. Attaining dataset listings as well as creating local new files or editing pre-existing ones.

Your IBM PC is a distributed SPF workstation allowing simultaneous local and remote SPF software.

Microcomputer uses are unparalleled when m3278/SPF operates under PC-DOS.

In addition, a multitask version of m3278/SPF is available for concurrent CP/M-86 users.

Users can perform several tasks at one time by swapping between functions and programs instantly.

For example, editing, compiling, and transferring can be performed simultaneously.

m3278/SPF emulates the 3278 terminal, yet surpasses its capabilities.

No time lost re-educating programmers.

With m3278/SPF™ experienced programmers can quickly and easily recognize the SPF emulation

characteristics and operate more efficiently.

Overloading eliminated.

By performing editing functions locally, problems related to mainframe overloading are eliminated.

Mainframe datasets or source programs can be brought down to the microcomputer. Using the same mainframe software in an off-line fashion, datasets can be modified and returned to the mainframe.

No overload. No downtime. No trouble.

How you can cut mainframe application software development backlog.

m3278/SPF™ is announced for the IBM Personal Computer\* and all IBM board compatible 16-bit microcomputers.

To find out how m3278/SPF™ can help turn the 3½-year wait into a tolerable number, contact us today.

```
EDIT -- SYSTEST.TST - 81.82
COMMAND INPUT ==> COLUMNS 801 P
000011  RESERVE 18 ALTERNATE AREAS.
000012  DATA DIVISION.
000013  FILE SELECTION.
000014  FD IS-FILE.
000015  BLOCK CONTAINS 5 RECORDS
000016  RECORDING MODE IS F
000017  LABEL RECORDS ARE STANDARD
                               micro/SPF PRIMARY OPTION MENU
                               SELECT OPTION ==> COLUMNS 801 P
                               SCROLL ==> HAD
                               USERID - PHASE
                               TIME - 02:55
                               TERMINAL - 13H P
                               PE KEYS - 12
B  SPF PARMS - SPECIFY micro/SPF PARAMETERS
1  BROWSE - DISPLAY SOURCE DATA
2  EDIT - CREATE OR CHANGE SOURCE DATA
3  UTILITIES - PERFORM micro/SPF UTILITY FUNCTIONS
T  TUTORIAL - DISPLAY INFORMATION ABOUT micro/SPF
X  EXIT - TERMINATE THE micro/SPF SESSION
PRESS END KEY TO TERMINATE micro/SPF
```

# PHASER

Mainframe Software for Micros

# Directions

ing technique mentioned above. Even some manufacturers whose products have traditionally been unprotected are now rumored to be considering protection. A number of firms are springing up to provide protection services (see Frank, "Software Piracy," *Tech Journal*, February, 1984.)

The reason for this is quite simple. There are now several million small computers installed, with several times that many to be installed over the next few years. Annual losses (that is, potential sales) to software vendors are currently estimated in the tens of millions of dollars, with estimates of future losses running in the hundreds of millions, perhaps even a billion. Software vendors can no more tolerate that kind of hole in their long-term cash flow than can any other manufacturer.

Stalemate. Or is it?

## A COUPLE OF SUGGESTIONS

A little bit of hardware could go a long way toward solving this problem. The first possibility is a hardware key that comes with the software. The program would refuse to run without the key inserted. The software diskettes can be completely in the clear. The program can run on whatever computer system happens to have the key (i.e., the key travels with the software).

This solution allows the manufacturer to force the purchaser to buy an appropriate number of keys. Such a purchase is more typical of purchasing in larger organizations, anyway. For example, a 20-person department would probably buy three, not twenty, subscriptions to *PC Magazine*. The three copies can be shared, and if they are not enough, more subscriptions can be ordered.

A number of companies now offer software this way. Ferox Microsystems originally offered Micro DSS/F with a key that plugged into the cassette port, a brilliant solution that the XT made obsolete. Sensor Based Systems delivers METAFILE with a key that inserts between the

serial port and serial cable, passing data freely when the METAFILE program is not active.

The big problem with this solution is that each package must come with its own key, and the purchaser must switch keys when switching programs. This is clearly more annoying than switching diskettes.

Another solution, one that has been used in the mainframe community for years, is a built-in hardware serial number identifying a specific PC. Software could refuse to operate except on its "own" machine.

The nice thing about this solution is that all machines from a manufacturer can be built with a unique identifier (the manufacturer numbers the things anyway), and all machines thus arrive with the feature built in. Older machines might be retrofitted with the new device; numbers could still be unique. Better yet, software developers would know that the device on all machines was the same, which would reduce their configuration-management problem.

The problem with this solution is that a purchased piece of software must be fitted to a particular machine before it can be used, and special arrangements must be made with dealers for demonstration copies. The unlocking process requires both a call to the software manufacturer (maybe over modem) to give them the serial number of the purchaser's system and a software process that actually accomplishes the unlocking process.

The only other thing needed is a way for the program to securely store the information about the serial number. If this information is easy to get at, modifying a copy of the software for a new machine becomes easy. That means multiple encodings must be used, and the encoding scheme must be protected at all costs. For example, a code in the beginning of a file gives the random position within the file where an encoded version of the serial number is stored. Also, the decoding scheme

must be carefully buried in the delivered software to prevent simple reverse engineering.

To allow the same flexibility as can be attained with software keys, and to allow effective service, the serial number must be detachable. The bigger problem is clearly service; people tend today to swap in an old, broken part for a new one. If the part happens to contain the serial-number device, the purchaser's software will not operate with the new machine. This problem might be overcome by algorithms that allow the software to be refitted to a new or repaired machine, but it is something all parties must consider.

The serial-number solution offers the maximum convenience to the users of media other than flexible diskettes. It costs the purchaser a little extra in the initial hardware buy, but nothing thereafter. The cost to the software manufacturer for the extra steps and personnel needed to implement such a method should be far less than the claimed lost revenues. The protection afforded should foil all but the most expert thieves and should stop casual reproduction.

## Listing Diskettes

Readers of *PC Tech Journal* who don't relish the task of typing in long listings from the articles we publish will be pleased to learn of a new service we are offering. *PC Tech Journal Listing Diskettes* are, obviously, diskettes, and they will carry the program listings that appear in print in the magazine. The first such diskette will carry listings from our first three issues, and the second diskette will cover issues four, five, and six. Thereafter, the diskettes will be published on a bimonthly basis and will include listings for two issues. Information on pricing and ordering can be found in our ad on page 147. Our hope is the Listing Diskettes will prove to be useful extensions to *PC Tech Journal*, leaving readers more time for other, more productive uses of their time with the PC.

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AST Research, the leader in IBM PC enhancement products, brightens your micro/mainframe communications picture with a full palette of economical, integrated hardware/software masterpieces. With AST Products, you can emulate IBM terminals or create PC-based Local Area Networks.

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AST communications products give your IBM PC the flexibility to act as a terminal for your host system or as a stand-alone computer for smaller tasks. Your PC won't bog down the mainframe with unnecessary small jobs and local computing on the PC eliminates phone line charges too. Get the power of a mainframe when you need it and personal computer convenience right at your fingertips.

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AST keeps pace with your ever-changing applications requirements with reliable, high quality, cost effective communications products. AST products provide support for Bisync and SNA/SDLC communications protocols as well as networking multiple PC's for sharing resources.

## Choose AST products — by the numbers.

These AST communications packages are currently available:

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3. **AST-PCOX™** allows your PC to connect to an IBM 3274/3276 cluster controller via coax cable and emulates a 3278 or 3279 display terminal.
4. **AST-3780™** emulates 2770, 2780, 3741, and 3780 RJE workstations using Bisync protocol.
5. **AST-5251™** emulates a 5251 Model 12 remote workstation connected to an IBM System 34, 36 or 38.
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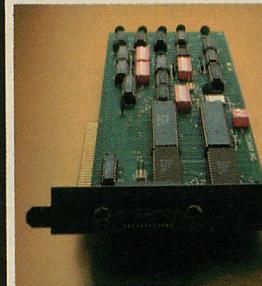
Our philosophy of total support adds uncommon value to your TECMAR products. All TECMAR boards feature a one-year warranty with guaranteed 72-hour maximum repair turnaround on all standard products. Replacement loaner units are available. Thorough and straightforward documentation comes with each unit. Our customer service staff is available to answer questions or solve your problems.

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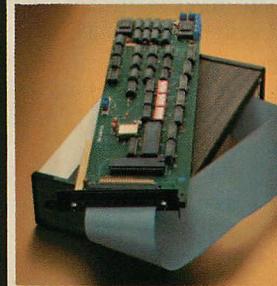
- High Resolution Graphics
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**IEEE488 INTERFACE  
plus SOFTWARE**

**\$395  
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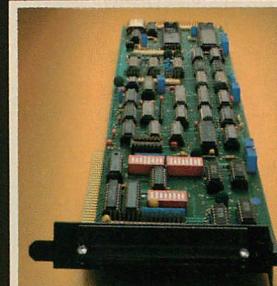
Board implements IEEE488 industry standard to enable PC to operate as system controller or as an addressed talker/listener. Has DMA and interrupt capabilities. Available library of machine-language subroutines called from BASIC or FORTRAN for data transactions with GPIB. Order #20030 INTERFACE, #30030 SOFTWARE.



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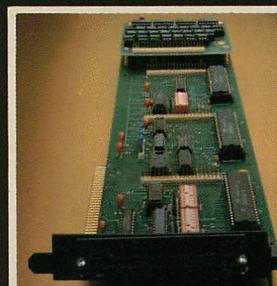
A sophisticated system that includes 16 channels of 12-bit A/D with a 30KHz conversion rate, two channels of 12-bit D/A, five timer/counters, and three 8-bit parallel ports. Options include programmable gain up to 1000, 14- and 16-bit accuracy, 40 and 100 KHz conversion, up to 256 channels. Order #20009.



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# PC MATE™

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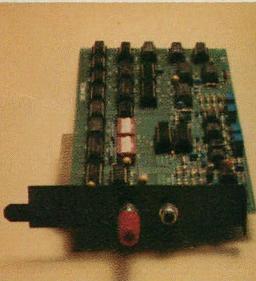
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This accurate, high-speed unit has four (4) independent channels of 12-bit digital-to-analog conversion that can be double-buffered (all four (4) output channels change simultaneously), with three (3) 8-bit parallel ports. Can control up to 24 digital devices.



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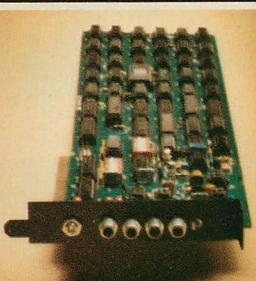
**VIDEO VAN GOGH  
plus SOFTWARE** \$345  
\$95

A video digitizer that interfaces TV cameras to the PC. Will digitize a black and white picture in six (6) seconds with resolution of 256H by 256V pixels and 256 grey levels. Software library sub-routines allow: digitization and display of a video picture, transfer to disk storage, image-printing, cursor control and point digitization.



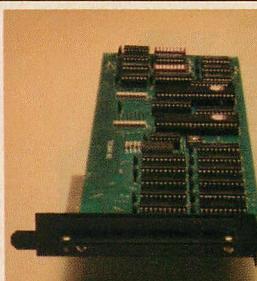
**DEVICE MASTER  
plus SOFTWARE** \$245  
\$35

Can be used for energy management, security, or just for convenience. This interface for the BSR X-10 unit turns electrical outlets on or off and dims lights without additional wiring. It uses no direct AC connection, avoiding damage to the computer. Contains a clock/calendar with alarm and battery back-up.



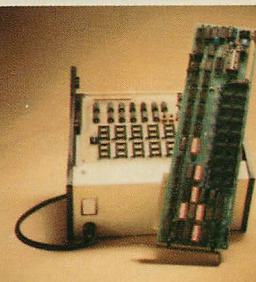
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Controls all remote functions on the SONY SC2500. Codes each frame so the user can locate any particular frame on the video tape, adds frame number information to any length recording, retrieves and displays exact frame by frame number, and when used with TECMAR'S GRAPHICS MASTER, a computer display can be super-imposed on the video picture.



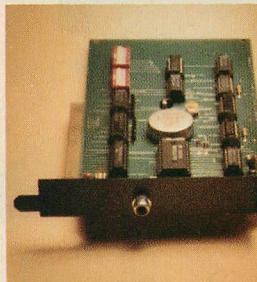
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A motor controller that gives you intelligent control of one (1) or two (2) stepper motors through the IBM PC. Will control four-phase or pulse actuated motors and has two (2) independent, buffered and labeled 8-bit TTL input ports and two (2) independent, buffered and labeled 8-bit TTL output ports.



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READER** \$495  
**E+EEPROM EXPANSION** \$595  
**E+EEPROM SOFTWARE** \$95

You can program and read EPROMs or EEPROMs with this unit. The expansion system provides 16 more sockets for individual or batch programming. The software is user-friendly, menu-driven routines that enable the user to acquire, receive and manipulate data to program EPROMs or EEPROMs. Serial communication and printer dump routines are included.



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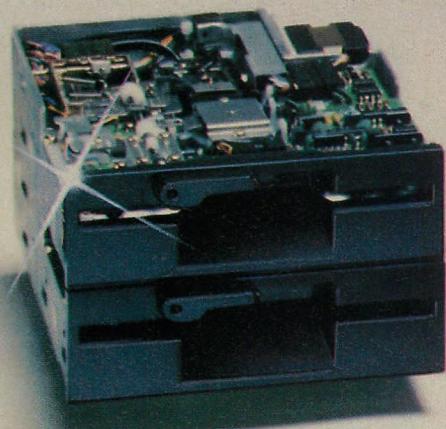
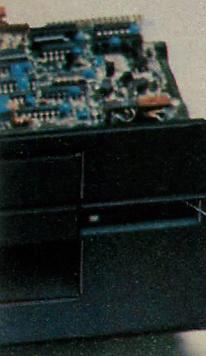
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# Letters to the Editor

## C HUNT

Bill Hunt has been providing a valuable service to those of us, familiar with FORTRAN and BASIC, currently trying to introduce ourselves to C. (PC TECH JOURNAL, "C and the PC, Part 1," Nov/Dec 1983 and "C and the PC, Part 2," Jan 1984.) We now have a good basis for selecting a C compiler. An additional service to us working programmers would be to acquaint us with how to access what must be a very large foundation of UNIX-based public domain C programs. Bell Laboratories and universities like the University of California at Berkeley must have developed hundreds of useful C utilities and applications that are available free or for nominal fees. There must also be user groups dedicated to implementation of C on the PC, which we might join in order to share our programming efforts and stop reinventing the wheel. I for one would appreciate any help you can offer introducing us to these sources.

Alan Hoshor  
Escondido, CA

*Bill Hunt replies: It is a fact of life that most software is written for money, not love. Most public domain software consists of small utility programs written in a month of evening and weekend work. Few people can spend months of full-time work producing a useful application program for free. Much of the available free UNIX software is not equal to commercial software products.*

*At present I am working on a book about tools programs in C. It contains listings of programs ready to compile and execute on the IBM PC. The programs include file dump utili-*

*ties, sorting programs, keyed file access, and terminal emulation programs. Since I get paid for my efforts, I can afford to spend time making C programs available.*

*There are quite a few software library products that can make the job of programming in C easier. Graphics, keyed file access, screen management, and access to PC-DOS and BIOS services are some of the functions offered by available products. The C-Food Smorgasbord product reviewed in Nov/Dec was one such product, and I will be reviewing several more in an upcoming issue. While these packages cost \$100 to \$400, they can save much more if you have a serious application.*

*In spite of what I have just said, there are some leads I can provide on free C (and UNIX) software: the August 1983 issue of BYTE magazine has lots of material on C. The article on pages 212-213 discusses UNIX and C resources. Three UNIX user groups are listed in that article.*

*The C Users Group (P.O. Box 287, Yates Center, KS 66783) has a catalog of public domain software available for \$12 per disk. In the past, the programs were designed for the CP/M-80 environment, but they are starting to offer software that works on the IBM PC under PC-DOS.*

*Dr. Dobbs Journal publishes source listings of C programs—mostly editors and utility programs.*

*Some libraries of public domain CP/M software contain source listings of C programs (the source files would have been moved from the CP/M format disks to IBM PC disks).*

Bill Hunt  
Walnut Creek, CA

## MALFUNCTION

I would like to commend you on the excellent review of multifunction boards for the PC included in the January issue of PC TECH JOURNAL.

However, I would like to point out a correction to the review of the IDEAssociates IDEAboard. Contrary to the information in the article, Printer Spooler and RAM floppy electronic disk software are included with our product at no extra charge. Chapters in the documentation address these two programs.

Nora Feldman  
Marketing Support Manager  
IDEAssociates, Inc.  
Bedford, MA

## DOS 2.0, UNDOCUMENTED

Just a quick note to tell you of a very useful, undocumented feature of PC DOS 2.0 that I discovered while looking in IBMBIO.COM. If you say

### SWITCHAR = —

in CONFIG.SYS, command syntax becomes UNIX-compatible in the sense that directory names are separated by "—" not "/". I am a regular UNIX user, and this removes a major complaint I had about DOS 2.0. Before, I always typed those incorrectly, sometimes with bad results. I wish they had documented it in the manual. More exactly, DOS apparently consistently recognizes "/" as well as "\\" or a directory separator, but it is usually hidden because COMMAND.COM takes "/" or the switch character.

J. Eric Roskos  
Nashville, TN

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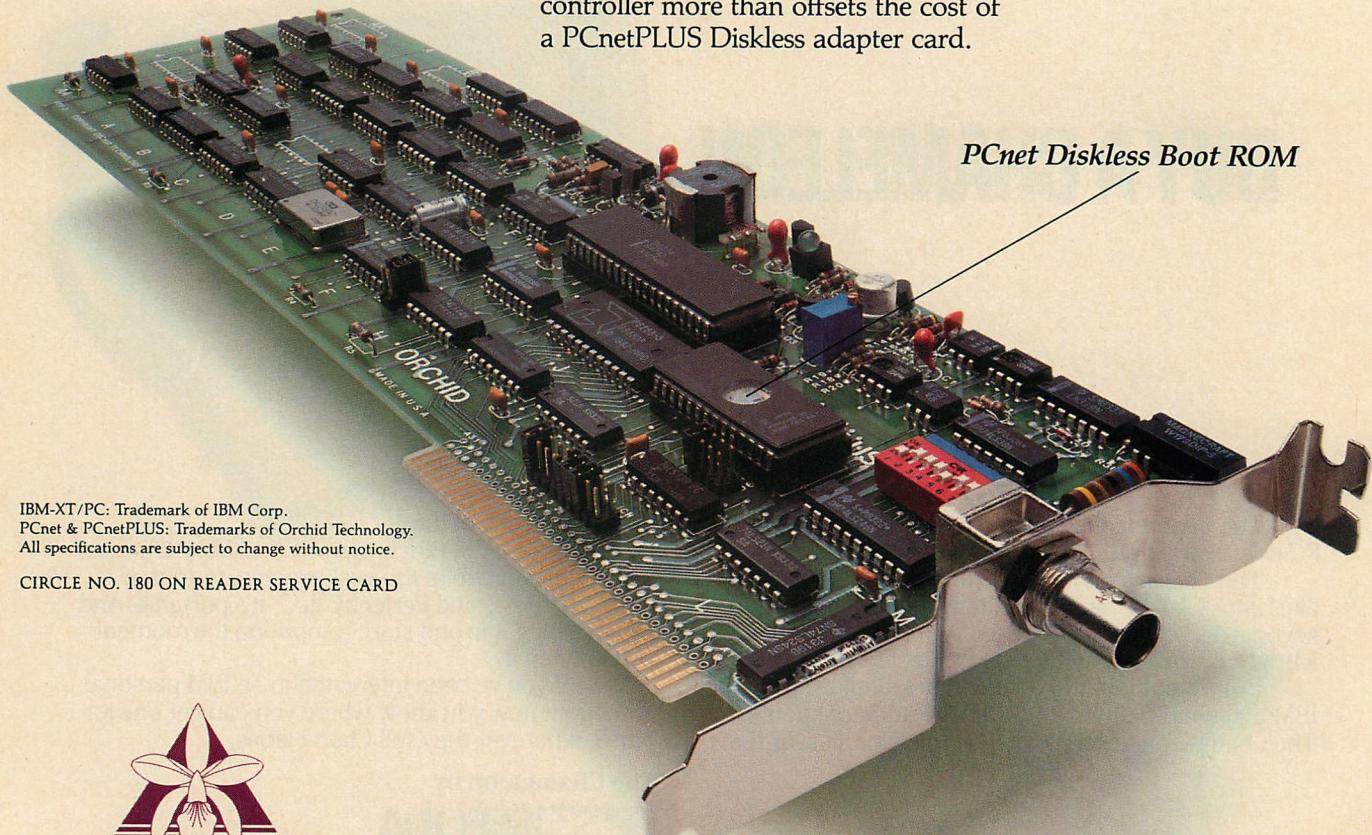
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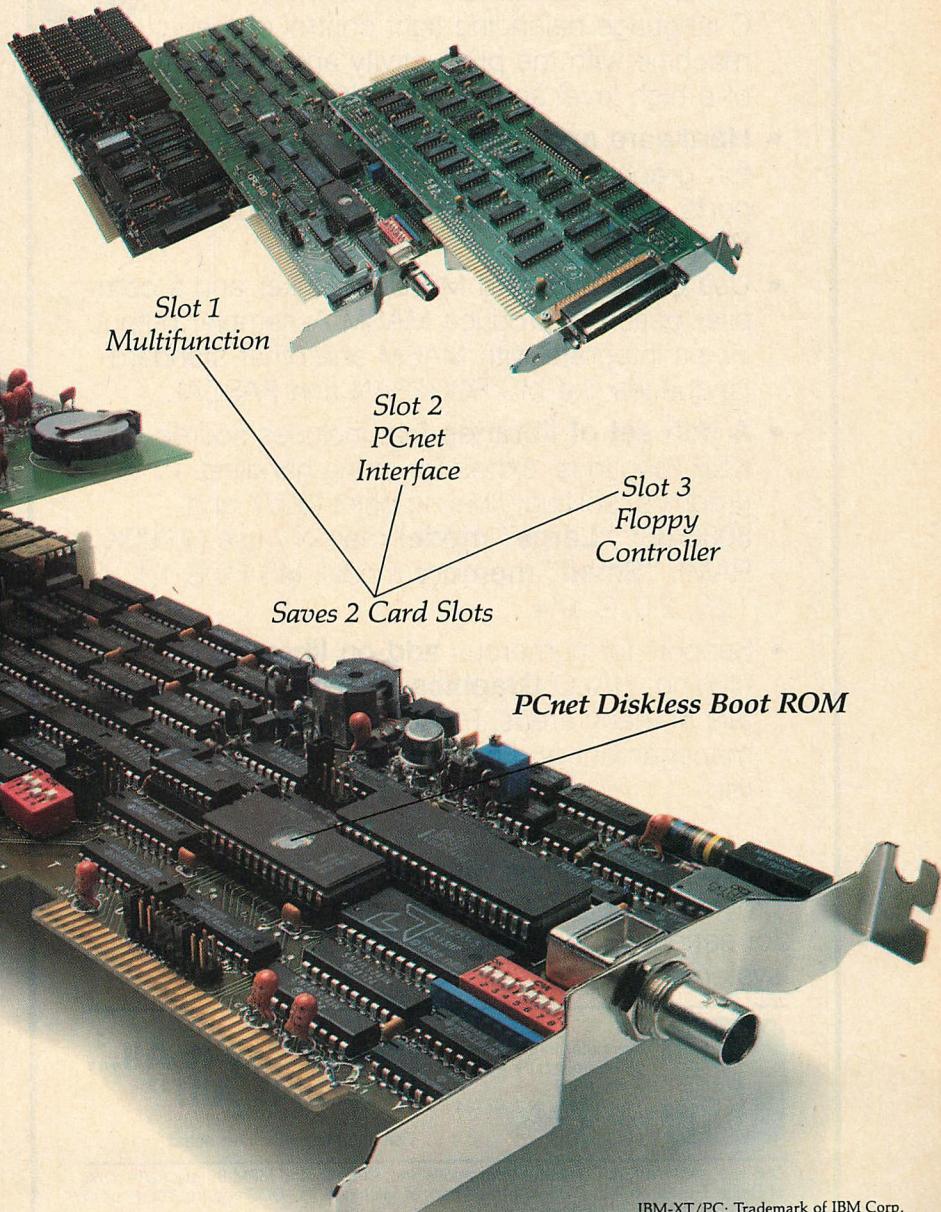
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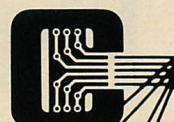


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## LETTERS

### INSIDE "INSIDE MICROSOFT BASIC"

Queries from readers caused us to discover several bugs in the listings for the article, "Inside Microsoft BASIC," by Robert Metzger in our Nov/Dec issue. In Listing 4, line 30, the closing quote was missing. There should be 40 spaces between the starting and ending quotes. What follows are corrections to the bugs in Listing 5:

—WF

```
290 INPUT "File name";X$ :  
OPEN X$ AS #1 LEN=128 :  
FIELD #1, 128 AS BB$ : C=129  
300 DIM S$(2000),P(2000) 'low memory?  
1060 GOSUB 1520 : B=A : GOSUB 1520 :  
IF A=0 AND B=0 THEN EF=1 : RETURN  
1065 GOSUB 1520 : B=A :  
GOSUB 1520 : L=B+256*A  
1270 IF I<J THEN SWAP S$(I),S$(J) :  
SWAP P(I),P(J)  
1275 IF I<J THEN 1250  
1280 SWAP S$(I),S$(H) : SWAP P(I),P(H)  
1290 IF (I-L)<(H-1)THEN 1320  
1530 IF C<129 THEN 1560 'more chars?  
1540 P$=B$ ' save buffer  
1550 GET #1 : B$ = BB$ : C=1  
1560 C$=MID$(B$,C,1) : A=ASC(C$) : C=C+1  
1570 IF SW=0 AND A=255 THEN SW=1 : A=0  
1580 RETURN  
1640 IF C=1 THEN B$=P$ : C=128 ELSE C=C-1
```

### BERT TO BETA

The Tech Notebook, "Nested Batch Files" (Nov/Dec, 1983) evidently has a misprint. The commands in ALPHA.BAT call for DOS to copy FILE1 to FILE2, then execute BETA.BAT. However, the batch file name called from ALPHA.BAT was printed as "bert".

Paul Hu  
Atlanta, GA

*There was indeed a typo; all berts should be betas.*

—WF

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### RANDOM RUMORS AND GOSSIP

**Tandy** (alias Radio Shack) is rumored ready to introduce an IBM-PC compatible "lap" battery-operated portable computer. It is expected to be made by Kyocera in the far east. Kyocera also makes the very successful Radio Shack 100 portable.

**Apple's** new "softcard" for the Lisa is expected to allow MS-DOS programs to run concurrently in one of the Lisa's windows. **IBM** is expected to start shipping its Xenix operating system for the CS-9000 system at last; the company announced the product more than six months ago. Look for **Keytronic** to be the first to announce a replacement keyboard for the PCjr. The keyboard will have an initial list price of \$225 and will sell for \$100 (for orders of 5,000) to OEMs developing PCjr compatibles. Rumor has it that **IBM** pays \$12 for its PCjr keyboard unit. There are rumors that **IBM** is looking for a fourth personal computer manufacturing fa-

cility in the Republic of Korea. **Samsuno Electronics Ltd.**, which already supplies monitors for the PC, is the leading contender. In the meantime, **IBM** added another 625,000 square feet to its facility in Boca Raton, Florida—the facility already had 3.6 million square feet.

### PC IN THE U.K.

IBM waited almost a year and a half before introducing the PC into the European and British markets. Until last January the only way to get a machine in those countries was to purchase it in the U.S. and have it shipped over; of course, the power supply then had to be adapted for the different voltage and frequency. As a result of the unavailability of the PC, "gray-market" importation developed. Some U.K. dealers bought machines from U.S. dealers, reworked the power supplies and advertised the machine for sale there. This was very expensive, but an estimated

2,000 machines came into the U.K. this way.

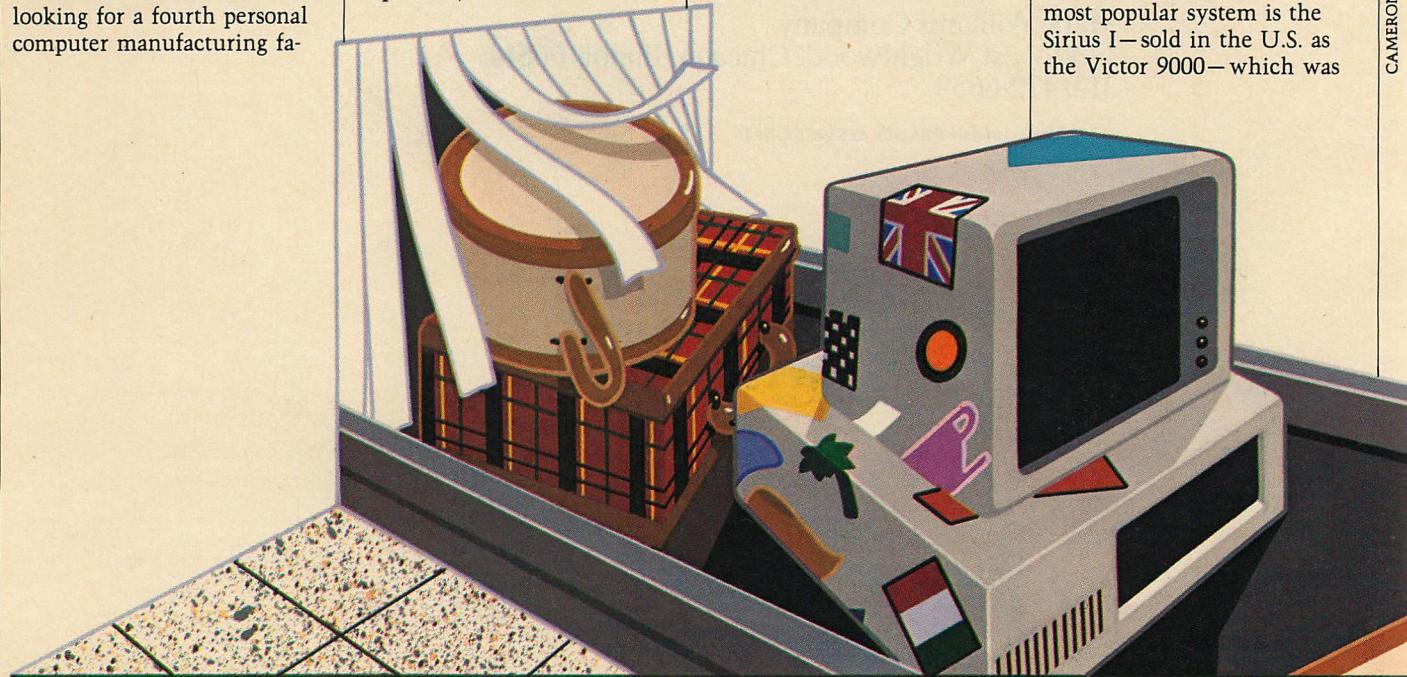
By July IBM already had 100 dealers carrying the machine in the U.K., and the gray market had disappeared. Today IBM is marketing the machine aggressively both in the U.K. and on the continent. It is interesting to note how IBM's marketing strategies for Europe and the U.K. differ from those for the U.S.

First, IBM is not using the little tramp in its promotions. Rather, it is using a lineup of different characters tailored to the different countries, all aimed at creating the image of user friendliness. For example, a series of full-page ads run in the London Telegraph shows a grand old dame wearing a big hat and beads using a PC.

Second, the European version of the machine has a different keyboard as well as power supply. The keyboards are different for different countries. For example, the U.K. keyboard has a pound-sterling symbol over the numeral 3 key. In all, eight different keyboards are

being made. The DOS contains a program that the user runs to tell the system which keyboard is being used. Also, the date that appears at sign-on time has been changed to conform to the European style (day/month/year).

Third, there is only one IBM-PC magazine in the U.K. compared to over a half-dozen here in the U.S. And as far as I can determine there are no IBM-PC user groups in operation yet. Purchasers are significantly different from the U.S. There are virtually no sales to private individuals; almost all are to large companies where the PC is used mainly as an intelligent terminal on a large mainframe. The lack of sales to home users and small businesses is no doubt attributable to the high cost of the machine relative to other systems made in the U.K. For example, a PC with 64K RAM, one drive, and a monochrome display costs about \$3,700. Despite this cost, however, the PC today occupies second place in desktop system sales. The most popular system is the Sirius I—sold in the U.S. as the Victor 9000—which was



# THE TECH JOURNAL NEWSLINE

introduced to the U.K. almost a year before the PC. Ranked third is the Olivetti M20. It is interesting to note the Apple IIe is reportedly a poor seller in the U.K., the Apple III being much more popular with business users.

Lastly, most of the software sold for the PC is U.S. developed and imported. There is typically a six-month lag between the introduction of software in the U.S. and its introduction in the U.K. Anglicized versions of word processors such as PeachText and EasyWriter are the most popular software programs; games have the least demand.

## IBM'S PROPRIETARY PC OPERATING SYSTEM

IBM is rumored readying a proprietary operating system for its soon-to-arrive 80286-based PC workstations. IBM has already proven on its recently introduced 3270/PC and 370/XT that it is well able to develop its own system software and that it is not really dependent on Microsoft for system software.

Such a move on the part of IBM would have the advantage of excluding competition from the "office-of-the-

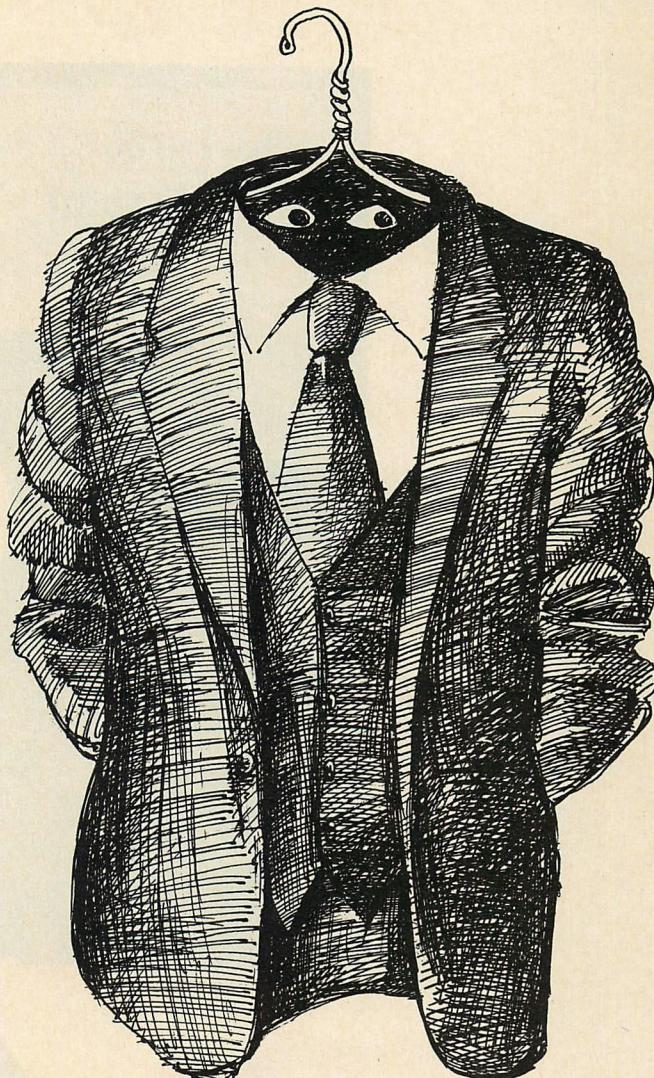
future" marketplace that IBM is seeking to dominate. IBM has a history of thwarting plug-compatible vendors via such tactics. A proprietary operating system with networking to IBM mainframes could have a devastating effect on companies such as Compaq, Corona, and the new imports from the far east. Microsoft and Digital Research are rumored to be aware of this eventuality and are said to be working on the problem. VisiCorp and Lotus are supposedly developing their own operating systems to overcome this problem.

There are rumors that the IBM proprietary workstation operating system will use windows, and that it will allow users to run different operating systems, such as PC-DOS, CP/M, UNIX, and IBM mainframe communications software, concurrently in different windows. IBM has already demonstrated some windowing capability on its recently introduced 3270 version of the PC.

## GOODBYE PINSTRIPES

In a recent interview, Gordon Garrett, general manager of IBM's Distribution Channels Unit, discussed the company's new sales strategy. He estimated that by 1987 as much as 30 percent of IBM's domestic revenue (about \$11 billion) would come from external channels rather than from IBM salespeople. He said that "IBM has an objective to participate in all sectors of the marketplace" and that "the strategy IBM has embarked on is to expand the marketplace by lowering price and as a result lowering the cost." Further, he said, "we do not intend to lower our margins as a result of doing so."

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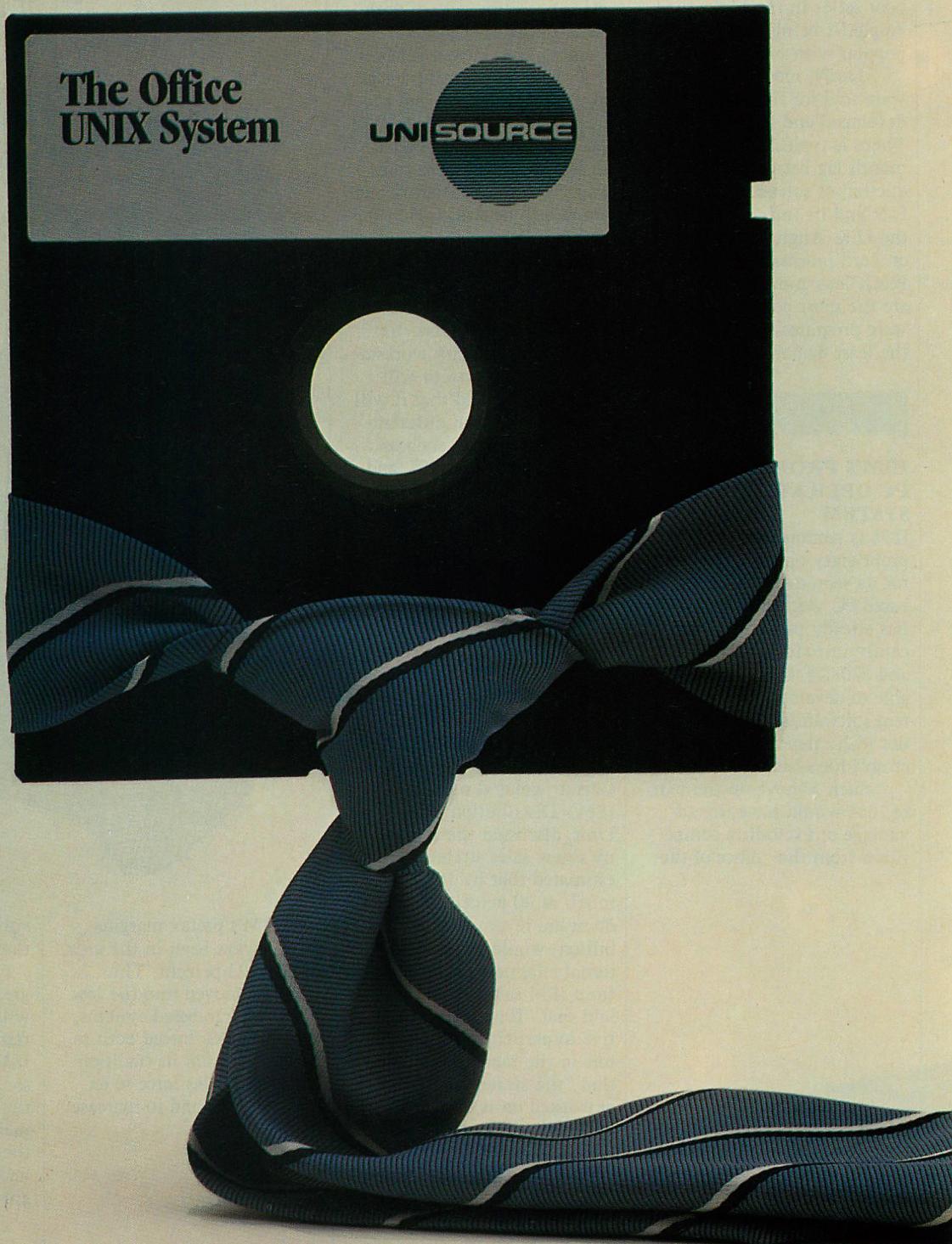


IBM's pretax margins have always been in the area of 20 to 25 percent. Thus, as IBM has moved into the low-margin micro-based systems, IBM has been forced both to turn away from its traditional internal sales force to external outlets and to increase

volume in order to maintain the company's profit levels.

IBM expects that the greater sales of IBM micros will boost sales of mainframes as well. The more IBM workstations and personal computers that exist, the greater the need for mainframe computers to link them. (IBM traditionally has had a 30-percent profit margin on mainframes.)

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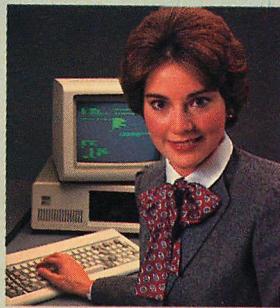
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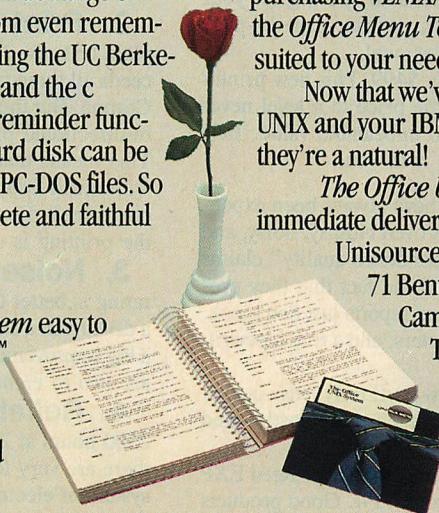
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## The Juki 6100: A daisy wheel printer with proportional spacing at an unheard of price.

The Juki 6100 has a lot of style to make you look your best. Handsome letter-quality typing and even proportional spacing for your correspondence and presentations. Stylish, perfect, page-by-page typing ready for binding. Slick and professional.

Yet we are offering the Juki 6100 for only \$499. This new printer has caught on so well that we can lower the price to a level never imagined for letter-quality printers! It's an unbeatable value. Take the time to read this ad, and we'll prove it to you.

Top performance letter-quality printers have always been expensive. And the lower priced attempts have proved clumsy, noisy, and slo-o-o-w. And don't be fooled by "correspondence quality" claims for matrix printers: there is no way around the fact that they produce characters from dot patterns. Letters and reports just don't look, well, *typed*. If you want fully-formed characters, and a true typewritten look, there is no shortcut.

Now comes the perfect combination: a low-cost, truly letter-quality printer, with a housing that makes it look much more costly—and it is even fast!

We benchmarked the nearest approximations, the Silver-Reed EXP 550, the Brother HR-1, and the Smith-Corona TP-1. Good products all. But then we put the Juki 6100 through its paces against this checklist:

**1. Print Quality.** This is where it really shines. Our printer uses print wheels and ribbons designed not for computer printers, but for *typewriters*—where the standards for "letter quality" are set. The printwheels are Triumph-Adler style: true typewriter quality, because that's what they were designed for. What's more, the printer uses IBM's Selectric II typewriter cartridges, so enough said about

quality of the ink and the print impression. Chances are you already stock these cartridges in your supplies cabinet.

**2. Print Speed.** Using the standard Shannon test for plain text, the Juki does a true 18 characters per second. That exceeds all three rival printers, and is half again faster than the Smith-Corona. But there is more. The Juki designers put in logic-seeking bi-directional printing and high speed motion over blank spaces. This means that typing speed on typical text is as fast as printers with much faster ratings. And there is a built-in, expendable 2,000 character buffer in the printer to free up your computer even before the printing is done.

**3. Noise level.** Quiet level is more accurate. The technical rating is better than 62 dBA from 1 meter away. If you don't know a dBA from a D&B, it means no raucous clatter to rattle the nerves, a big improvement over some printers we listened to. The other three are *two to eight times noisier*.

**4. Reliability.** The engineers know what an MTBF of 2500 hours at 25% duty means. More meaningful for most of us: there are very few moving parts. Other printers employ a complex system of electric motors, wires, pulleys, and springs. Not only do they break down, they also go out of adjustment. But the Juki uses a far more elegant design: the printhead glides across a rail by magnetic traction. That's all there is to it. If you look inside, you will see a startling simplicity.

**5. Warranty.** We give you a full 90 days limited warranty which covers parts and labor, but we don't think you'll be testing this part of our offer. Still, it's nice to know it's there. It means you really cannot go wrong by ordering this printer to put it through its paces.

# letter-quality printer for \$499!

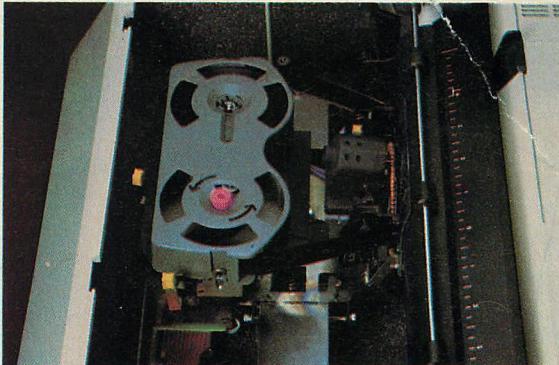
Shipping and Handling Extra

**6. Versatility.** Our printer can print at 10, 12 and 15 characters per inch and also take proportional spaced wheels for that extra touch of class. We also have an economical and reliable bi-directional forms tractor as an option, if you want to handle continuous stationery.

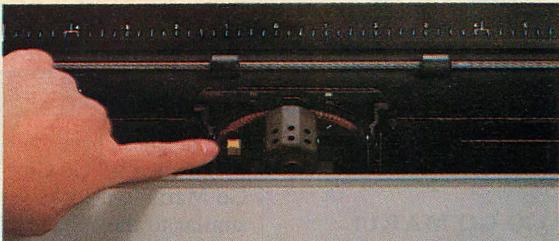
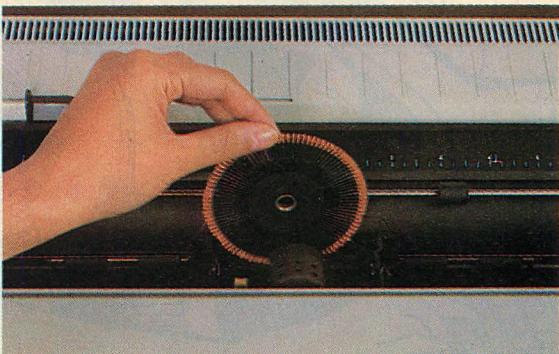
We supply a 100-character Courier 10-pitch (characters per inch) printwheel with the full ASCII character set and extra word processing symbols. The other three printers can't match that: Smith-Corona has only 88.

## 7. Physical Specifications.

Print Speed:	18 characters/second
Daisywheel:	Triumph-Adler compatible. Drops into place
Printing Characters:	100 per wheel
Printed Line Length:	110 characters under 10 pitch 132 characters under 12 pitch 165 characters under 15 pitch 82 to 220 characters under proportional spacing mode
Horizontal Resolution:	1/120 inch minimum
Vertical Resolution:	1/48 inch (1/96 inch possible by using escape sequence)
Platen Size:	13 inches (Printing line 11 inches)
Ribbon:	IBM82 Compatible multi-strike or single strike (Selectric II)
Interface:	Centronics parallel. Diablo® software compatible.
Power Consumption:	40 W idling, average 80 W printing
Dimensions:	Width: 20.5", Depth: 17.9", Height: 5.9"
Weight:	31 lbs.
Environment:	Ambient Temperature: 41° to 95° Farenheit Relative Humidity: 30% to 85%
MTBF:	2,500 hours at 25% duty
MTTR:	15 minutes
Noise:	Less than 62 dBA at 1 meter distance
Buffer Memory Size:	2K bytes installed, expandable to 8K.
Options:	Bi-Directional Forms Tractor, \$129.00



Above: Easily accessed controls are on the front panel. The printhead, ribbon, and printwheel are mounted as a single mechanism. Below: The printwheel simply drops into place; the printer engages it automatically!



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PC Brand has printwheels and ribbons for the Juki 6100, and a range of personal computer supplies. Ask for our catalog. Prices and specifications are subject to change without notice.

# THE TECH JOURNAL NEWSLINE



## GO GO GO MARU!

The PC is sold in Japan via Computerland stores. The sales are so minimal that the system is effectively a non-entity; it is bought mostly by foreigners. Fear not! IBM, in its infinite wisdom (witness Apple, DEC, et al.) has introduced a desktop system customized for the Japanese market, and it has taken off like a skyrocket. Called the 5550

(the Japanese have nicknamed it "Go Go Go Maru!"), it looks very similar to the PC and is the first personal computer to gain any acceptance in Japan's business community. Until now, virtually all the personal computers sold in Japan were aimed at hobbyists, engineers, or scientists. They either played games or ran CP/M.

To develop this system, IBM went to Matsushita (whose subsidiaries are Panasonic, Technics, and National) and asked it to design and produce a version of the PC tailored to the Japanese mar-

ket so that the machine can select a character based on the context. Software was also developed for terminal emulation to large mainframes and for local data processing. Thus the 5550 is the first low-cost desktop machine to hit Japan which can run more than one application. Hence its success.

Further, IBM has chosen not to go with the lovable Tramp in its advertising, deciding instead to use Tora-san, known throughout Japan as a chump, a perennial go-nowhere dressed in a blue-serge smoking jacket with a matching fedora. IBM's marketing is different, too. Rather than sell the 5550 via chains and independent dealers, IBM created a separate sales company.

## IBM INCREASES STAKE IN INTEL

IBM has increased its stake in Intel from 15.2 to 16.28 percent. Under an agreement between the two companies, IBM can own up to a maximum of 30 percent of Intel. This latest increase is estimated to have cost IBM about \$83 million.

ket. The most difficult problem was designing a low-cost word processor capable of generating and accessing the 8 to 9,000 Kanji characters used in Japanese text. Matsushita devised a word processor that allows the user to enter the sound of the word using a Japanese phonetic al-

## QUOTATION OF THE MONTH

John Sculley, president of Apple Computer Corporation, during a presentation given at a meeting of the New York Society of Security Analysts: "Lisa captured corporate America's imagination, but IBM captured corporate America. The IBM XT/370 will ultimately control corporate America."

# ES/P.

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ES/P is the new program entry system from Bellesoft that enables programmers to write 50% faster and 100% better. ES/P has • **on-line syntax checking** • **on-line formatting** • **on-line language help** • **language oriented abbreviations**. It automatically warns the user about any unbalanced pair of quotes, parentheses, and brackets, saving hours of compiling and debugging time. Code is automatically formatted maintaining a consistent standard. Complete structures are built with a single keystroke. Menus of correct program components are offered on-line. Thousands of keystrokes are saved daily. Other features include: split-screen editing of up to 4 files; users may copy, move, and delete ranges of code within a file and between windows; and ES/P is completely crash resistant. There's never been a better way to write, debug, modify and maintain programs. Think fast. Get ES/P. Pascal and C versions are available for the IBM PC. Fortran and Cobol in early 1984. Bellesoft, Inc., 2127 Bellevue Way S.E., Bellevue, WA 98004. (206) 451-9788.

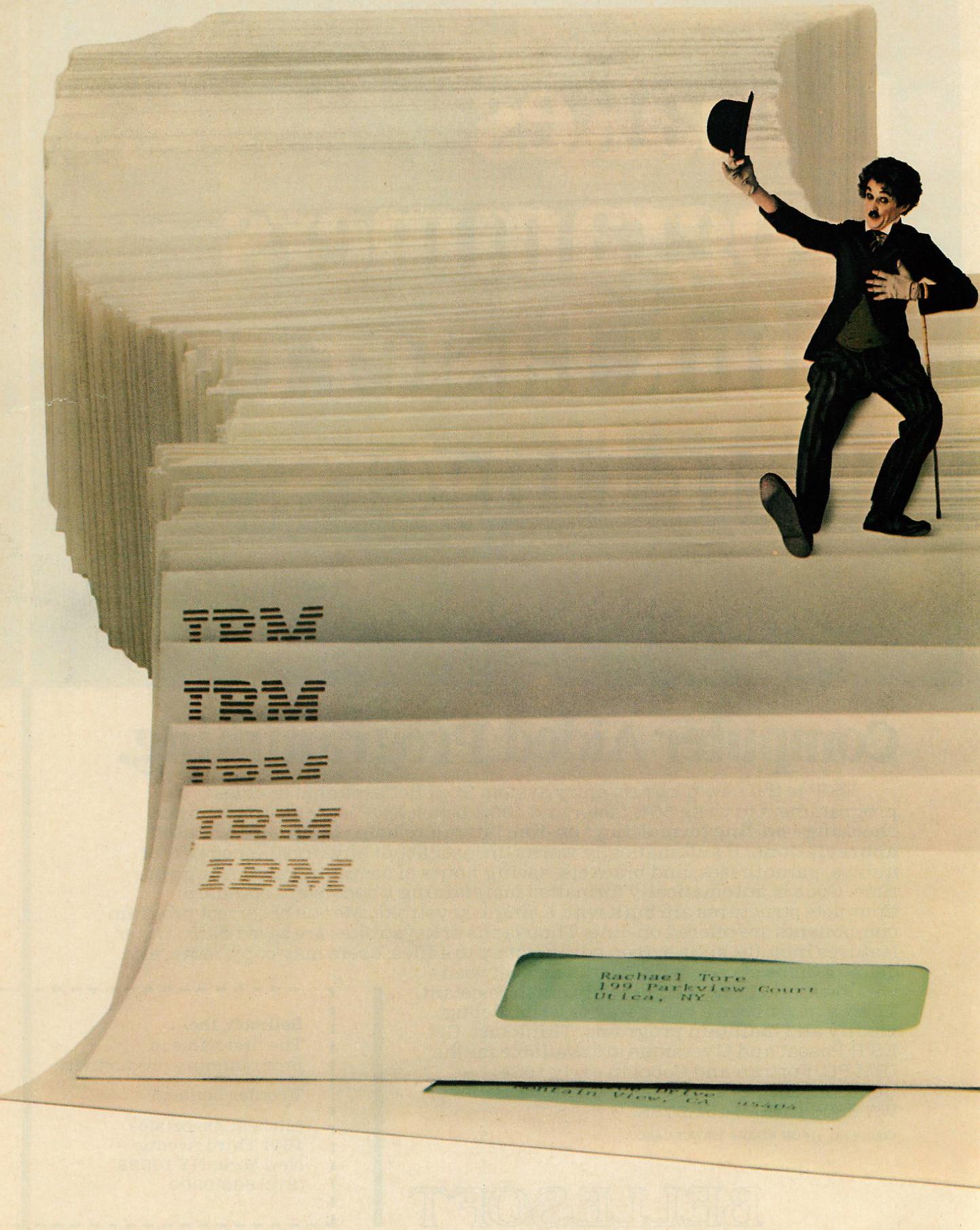
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programs. And graphics. And games.

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64K-640K bytes	Color or monochrome	(ROM) 40K bytes
<b>Microprocessor</b>	High-resolution	
16-bit, 8088	80 characters x 25 lines	
<b>Auxiliary Memory</b>	Upper and lower case	
2 optional internal diskette drives, 5 1/4"	<b>Operating Systems</b>	
160KB/180KB or 320KB/360KB per diskette	DOS, UCSD p-System, CP/M-86	
<b>Keyboard</b>	<b>Languages</b>	
83 keys, 6 ft. cord attaches to system unit	BASIC, Pascal, FORTRAN, MACRO Assembler, COBOL	
10 function keys	<b>Printer</b>	
10-key numeric pad	All-points-addressable graphics capability	
<b>Diagnostics</b>	Bi-directional	
Power-on self testing	80 characters/second	
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# Plotting, Drawing & Filling

*An excerpt on graphics  
from Bluebook of Assembly  
Routines for the IBM PC*

The advent of personal computers with color video graphics has recently made computer graphics a cost-effective alternative to the time-consuming and laborious hand-drawing of pictures. The following routines perform fundamental plotting jobs on the IBM PC color graphics screen, including point plotting, line drawing, character plotting, and area filling. These routines have been optimized for speed, register usage, and simplicity. Point-plotting and line-drawing routines are emphasized.

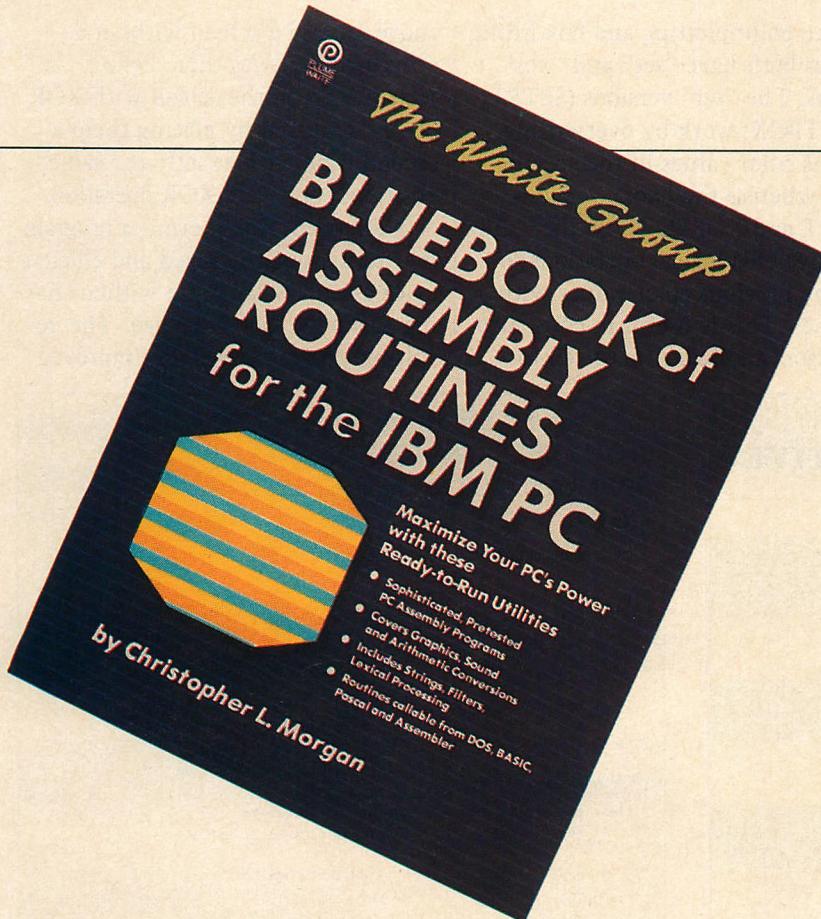
The programs are divided into primitive and second-level functions. The primitive functions discussed include routines to clear the screen, plot a point, plot a point using XOR, locate a point, fill a box, and fill a box. These routines do not call any others; they are used by other routines for screen access.

The article covers only one second-level function—SETLINE (Draw a Line). Second-level functions must perform their tasks quickly and so should be written in assembly language. However, they call upon primitive functions to access the screen.

The point-plotting routine that follows plots about 10,000 points a second, more than three times faster

than the point-plotting routine in the IBM ROM BIOS. The line-drawing routine (SETLINE) uses Bresenham's algorithm, a popular and fast algorithm. Its critical loop consists of a call to the point-plotting routine plus a handful of 8088 instructions. Thus, optimization of point plotting is the dominant factor in optimizing the speed of this line-drawing routine, which plotted about 8,000 points per second. The overhead due to the line-drawing routine itself can be reduced by a factor of two to yield about 9,000 points per second if self-modifying code is used (see the routine by Dan Rollins on pages 75-77 in *Doctor Dobb's Journal*, June, 1983). However, self-modifying code is considered poor

CHRISTOPHER L. MORGAN



# Using Assembly Language Routines

## A Note from the Waite Group

This is the first of three articles to be excerpted in *PC Tech Journal* from the forthcoming *Bluebook of Assembly Routines for the IBM PC*, a Waite Group book by Christopher L. Morgan. It contains fast, efficient assembly routines for a wide variety of applications; the excerpt here is part of the chapter on graphics. (Morgan is also the author, with Mitchell Waite, of *8086/8088 16-Bit Microprocessor Primer*, and *Graphics Primer for the IBM PC*.) The book is part of the *New American Library* series of IBM PC computer-language books issued under the Plume/Waite imprint.

The second excerpt, which will appear in April, will deal with assembly language routines to control the sound

capabilities of the IBM PC.

There are many programming situations that higher-level languages such as BASIC and Pascal cannot handle. Sometimes the higher-level language is too slow; sometimes it lacks the ability to directly access a particular hardware feature. In these situations assembly language is the solution. It is the fastest language available on a computer, and it can access all of a machine's hardware.

Of course, not everyone can program in assembly language. Although the difficulty of learning assembly language is often exaggerated, it may not nevertheless make sense to learn a whole new language simply to write a routine or two to carry out a specific function. But how can the speed and power of assembly language be accessed by someone who is not fami-

liar with that language?

The following group of assembly language routines can be used to handle all the common graphics functions on the IBM PC. Assembly language is almost essential in the area of graphics, because producing pictures of moving objects on the screen requires great speed.

It is not necessary to know assembly language to use these routines. The text that accompanies the routines explains how to plug the routines into BASIC or Pascal programs and thus achieve the speed and power of assembly language in critical situations without having to understand the esoterics of assembly language programming. Anyone who has ever been frustrated by the things that can't be done in higher-level languages will find these routines helpful.

# GRAPHICS EXCERPT

programming practice, so we have not used it.

Box-filling routines (SETBOX and XORPT) have been included to fill large rectangular areas quickly. These routines can fill a whole screen in about a fifth of a second (compared with 6.4 seconds for plotting every point on the screen). To clear the whole screen in less than a tenth of a second, use CLS.

The point-plotting and box-filling routines both have "set" and "xor" versions. The "set" versions (SETPT and SETBOX) work by overwriting previous color values in the specified pixels, whereas the "xor" versions (XORPT and XORBOX) use the XOR (exclusive OR) logical operations to combine previous color values with new ones. This is useful in constructing cursors and icons that need to

move around a screen without destroying what was there before. Objects placed on the screen with XOR can be removed by placing them a second time with exactly the same position, color, and XOR operation.

These routines permit a programmer to harness the speed and efficiency of assembly language without having to know that language. The resulting programs will be improved.

## LISTING 1—CONSTANTS AND DEFINITIONS USED IN PRIMITIVE FUNCTIONS

```
; For 320 x 200 color graphics mode
;
;*****
datas segment public
;
    public x0,y0,x1,y1,x2,y2
    public color
;
    public parameters
x0    dw    ?
y0    dw    ?
x1    dw    ?
y1    dw    ?
x2    dw    ?
y2    dw    ?
color  dw    ?
;
; tables of color masks for filling boxes
cbytes db    000h, 055h, 0AAh, 0FFh
;
xtable dw    OFFC0h, OFFF0h, OFFFCh, 0FFFh
        dw    03FC0h, 03FF0h, 03FFCh, 03FFFh
        dw    00FC0h, 00FF0h, 00FFCh, 00FFFh
        dw    003C0h, 003F0h, 003FCh, 003FFh
;
; table of color masks for plotting points
ctable dw    0003Fh, 0403Fh, 0803Fh, 0C03Fh
        dw    000CFh, 010CFh, 020CFh, 030CFh
        dw    000F3h, 004F3h, 008F3h, 00CF3h
        dw    000FCh, 001FCh, 002FCh, 003FCh
;
datas ends
;*****
video segment at 0B800h
video ends
;*****
ex4prim segment
;
    public cls
    public setpt,xorpt,locate
    public setbox,xorbox
;
assume cs:ex4prim,ds:datas,es:video
```

## LISTING 2 CLS—CLEAR THE SCREEN

### Clear the Graphics Screen

**FUNCTION:** This routine clears the color graphics screen.

**INPUT:** None

**OUTPUT:** Just to the screen

**REGISTERS USED:** No registers are modified.

**SEGMENTS REFERENCED:** Upon entry ES

must point to the screen RAM at B8000h.

**ROUTINES CALLED:** None

**SPECIAL NOTES:** None

### CODE:

```
; ROUTINE TO CLEAR THE GRAPHICS SCREEN
;
cls    proc    far;
        push   cx           ; save registers
        push   ax
;
        ; set up the registers
        mov    cx,2000h      ; word count of whole screen
        mov    ax,0           ; zero pattern for the screen
        mov    di,ax          ; set starting address
        cld
;
        ; clear the screen with a single string operation
        rep    stosw         ; this clears the screen
;
        pop    ax           ; restore registers
        pop    cx
        ret
cls    endp
```

## LISTING 3 SETPT—PLOT A POINT

### Plot a Point on the Medium Resolution Color Screen

**FUNCTION:** This routine plots a point on the medium-resolution color graphics screen. The pixel at the specified location is given a specified color, overwriting the old color.

**INPUT:** Upon entry:

x-coordinate (0-319) of the point is in SI  
y-coordinate (0-199) of the point is in DI  
color (0-3) is in DX

**OUTPUT:** Just to the screen

**REGISTERS USED:** No registers are modified. SI, DI, and DX are used for input.

**SEGMENTS REFERENCED:** Upon entry ES must point to the video RAM at B8000h and DS must point to a data segment containing the following look-up table of rotated color masks:

```
ctable
dw 0003Fh,0403Fh, 0803Fh,0C03Fh
dw 000CFh,010CFh, 020CFh,030CFh
dw 000F3h,004F3h, 008F3h,00CF3h
dw 000FCh, 001FCh, 002FCh,003FCh
```

### ROUTINES CALLED: None

**SPECIAL NOTES:** No bounds-checking is performed. The user must make sure that the coordinates and the color are in their proper ranges.

### CODE:

```
; ROUTINE TO PLOT A POINT ON MEDIUM RES COLOR SCREEN
;
setpt proc far
;
    push bx          ; save registers
    push si
    push ax

;
; multiply y-coord by bytes per row and adjust for even/odd lines
    mov ax,d1          ; get y-coord into low part
    mov ah,al          ; and into high part
    and ax,01FEh        ; mask off unwanted parts
    sal ax,1           ; times 4
    sal ax,1           ; times 8
    sal ax,1           ; times 16
    mov bx,ax          ; goes into address
    and bh,7           ; without adjustment
    sal ax,1           ; times 32
    sal ax,1           ; times 64
    add bx,ax          ; address gets y-coord times 80
;
; add x-coord to address
    mov ax,si          ; get x-coordinate
    sar ax,1           ; divide
    sar ax,1           ; by 4
    add bx,ax          ; here is the address
;
; compute the rotated mask and color
    and si,3           ; just pixel position into the index
    sal si,1           ; index times 2
    sal si,1           ; index times 4
    add si,dx          ; 4*pixel position + color
    sal si,1           ; 8*pixel position + 2*color
    mov ax,ctable[si]   ; look up rotated color and mask
;
; insert the color into the video byte
    and al,es:[bx]      ; get old byte & remove old pixel
    or al,ah           ; insert new color
    mov es:[bx],al      ; put the byte back
;
    pop ax             ; restore registers
    pop si
    pop bx
    ret
;
setpt endp
```

### LISTING 4 XORPT—PLOT A POINT USING XOR

#### XORPT

#### Xor a Point onto the Medium-Resolution Color Screen

**FUNCTION:** This routine plots a point on the medium-resolution screen using the "exclusive or" operation. The pixel at the specified location is colored with a color obtained by "exclusive oring" its original color with a specified color. This function is useful for making cursors.

**INPUT:** Upon entry:

x-coordinate (0-319) of the point is in SI

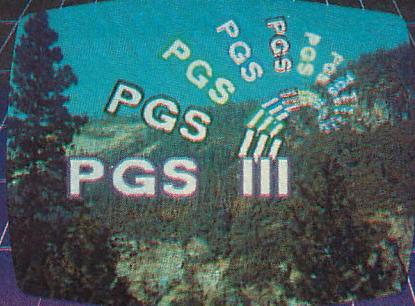
y-coordinate (0-199) of the point is in DI

color mask (0-3) for xor is in DX

**OUTPUT:** Just to the screen

**REGISTERS USED:** No registers are modified. SI,

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# GRAPHICS EXCERPT

DI, and DX are used for input.

**SEGMENTS REFERENCED:** Upon entry ES must point to the video RAM at B8000h and DS must point to a data segment containing the following look-up table for rotated color masks:

```
ctable
dw 0003Fh,0403Fh, 0803Fh,0C03Fh
dw 000CFh,010CFh, 020CFh,030CFh
dw 000F3h,004F3h, 008F3h,00CF3h
dw 000FCh,001FCh, 002FCh,003FCh
```

**ROUTINES CALLED:** None

**SPECIAL NOTES:** No bounds-checking is performed. The user must make sure that the coordinates and the color are in their proper ranges.

**CODE:**

```
; ROUTINE TO XOR A POINT ONTO MEDIUM RES COLOR SCREEN
;
xorpt proc far
;
    push bx          ; save registers
    push si
    push ax
;
; multiply y-coord by bytes per row and adjust for even/odd lines
    mov ax,di        ; get y-coord into low part
    mov ah,al        ; and into high part
    and ax,01FEh     ; mask off unwanted parts
    sal ax,1         ; times 4
    sal ax,1         ; times 8
    sal ax,1         ; times 16
    mov bx,ax        ; goes into address
    and bh,7         ; without adjustment
    sal ax,1         ; times 32
    sal ax,1         ; times 64
    add bx,ax        ; address gets y-coord times 80
;
; add x-coord to address
    mov ax,si        ; get x-coordinate
    sar ax,1         ; divide
    sar ax,1         ; by 4
    add bx,ax        ; here is the address
;
; compute the mask for color and use it
    and si,3         ; just the bit count into the index
    sal si,1         ; index times 2
    sal si,1         ; index times 4
    add si,dx        ; 4*pixel position + color
    sal si,1         ; 8*pixel position + 2*color
    mov ax,ctable[si] ; look up the masks
    xor es:[bx],ah   ; xor the byte with the color
;
    pop ax          ; restore registers
    pop si
    pop bx
;
    ret
;
xorpt endp
```

## LISTING 5 LOCATE—LOCATE A POINT ON THE MEDIUM-RESOLUTION COLOR SCREEN

### LOCATE

**Locate a Point on the Medium-Resolution Color Screen**

**FUNCTION:** This routine returns the color of a

point on the medium-resolution screen. The color is returned in AL.

**INPUT:** Upon entry:

x-coordinate (0-319) of the point is in SI  
y-coordinate (0-199) of the point is in DI

**OUTPUT:** Upon exit AL contains the color (0-3) of the pixel at the specified location.

**REGISTERS USED:** Only AX is modified. SI and DI are used for input and AL is used for output.

**SEGMENTS REFERENCED:** Upon entry ES must point to the video RAM at B8000h.

**ROUTINES CALLED:** None

**SPECIAL NOTES:** No bounds-checking is performed. The user must make sure that the coordinates are in their proper ranges.

**CODE:**

```
; ROUTINE TO RETURN COLOR OF A POINT ON MEDIUM RES COLOR SCREEN
;
locate proc far
;
    push bx          ; save registers
    push cx
;
; multiply y-coord by bytes per row and adjust for even/odd lines
    mov ax,di        ; get y-coord into low part
    mov ah,al        ; and into high part
    and ax,01FEh     ; mask off unwanted parts
    sal ax,1         ; times 4
    sal ax,1         ; times 8
    sal ax,1         ; times 16
    mov bx,ax        ; goes into address
    and bh,7         ; without adjustment
    sal ax,1         ; times 32
    sal ax,1         ; times 64
    add bx,ax        ; address gets times 64 + times 16
;
; add x-coord to address
    mov ax,si        ; get x-coordinate
    sar ax,1         ; divide
    sar ax,1         ; by 4
    add bx,ax        ; here is the address
;
; compute the position of the pixel in the byte
    mov cx,si        ; use x-coordinate to determine count
    and cx,3         ; just the bit count
    inc cx          ; plus one
    sal cx,1         ; 2 bits per pixel
;
; get the byte and rotate into place
    mov al,es:[bx]   ; get old byte
    rol al,cl        ; rotate left this many times
    and ax,3         ; just the pixel color
;
    pop cx          ; restore the registers
    pop bx
    ret
;
locate endp
```

## LISTING 6 SETBOX—FILL A RECTANGULAR BOX

### SETBOX

**Fill a Rectangular Box with Color**

**FUNCTION:** This routine fills a rectangular box in the color graphics screen with a given color.

**INPUT:** Upon entry:

x-coordinate of upper left corner is in xl

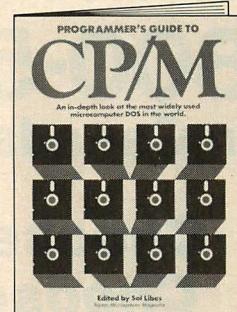
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Edited by Sol Libes

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y-coordinate of upper left corner is in y1  
x-coordinate of lower right corner is in x2  
y-coordinate of lower right corner is in y2  
color of the rectangle is in bits 0 and 1 of color

**OUTPUT:** Just to the screen

**REGISTERS USED:** No registers are modified.

**SEGMENTS REFERENCED:** Upon entry ES must point to the video RAM at B8000h and DS must point to the following look-up table for color masks:

```
xtable
dw 0FFC0h,0FFF0h,0FFFCh,0FFFFh
dw 03FC0h,03FF0h,03FFCh,03FFFh
dw 00FC0h,00FF0h,00FFCh,00FFFh
dw 003C0h,003F0h,003FCh,003FFh;
```

**ROUTINES CALLED:** None

**SPECIAL NOTES:** No bounds-checking is performed. The coordinates must be in range and in order. That is, the following must be true:

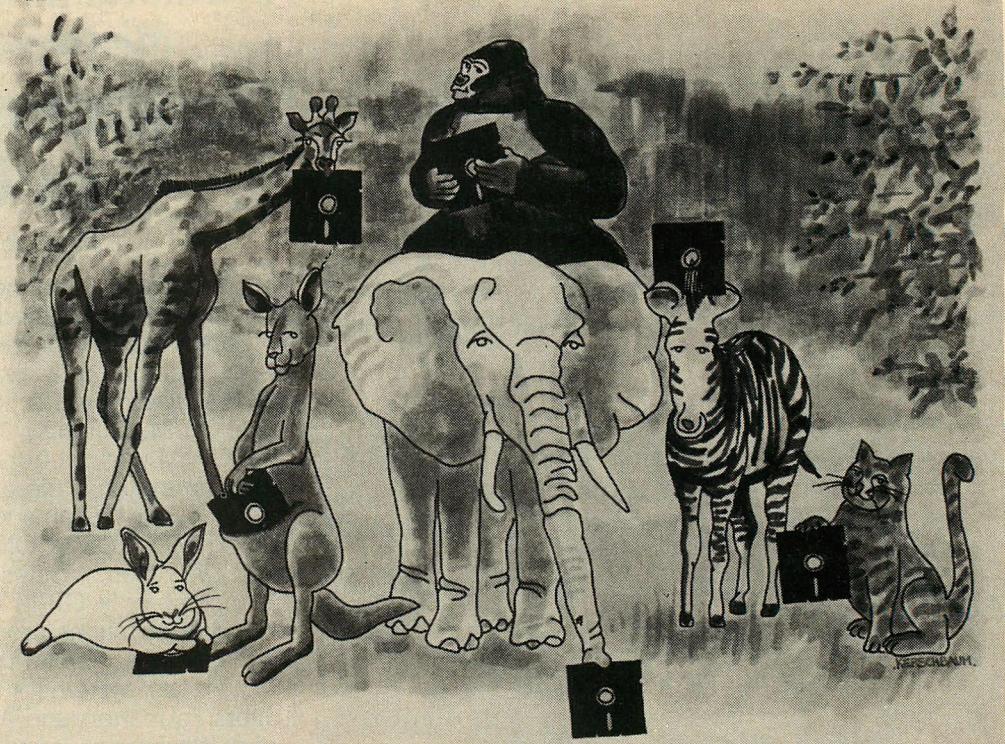
$$0 \leq x1 \leq x2 \leq 319$$
$$0 \leq y1 \leq y2 \leq 199$$

**CODE:**

```
; ROUTINE TO FILL A RECTANGULAR BOX
;
setbox proc far
;
    push si           ; save registers
    push di
    push dx
    push bx
    push cx
    push ax
;
; determine byte position for start
;
; get y contribution
    mov ax,y1          ; get starting y-coordinate
    mov ah,al          ; replicate for odd/even bank
    and ax,1FH          ; just one bit gets moved
    sal ax,1           ; times 4
    sal ax,1           ; times 8
    sal ax,1           ; times 16
    mov di,ax          ; address gets 16 times y-coordinate
    and di,7FFh          ; not the odd/even bit
    sal ax,1           ; times 32
    sal ax,1           ; times 64
    add di,ax          ; address gets 80 times y-coordinate
;
; add in x contribution
    mov ax,x1          ; get x-coordinate
    sar ax,1           ; divide
    sar ax,1           ; by 4
    add di,ax          ; beginning offset
;
; count for outer loop
    mov cx,y2          ; ending y-coordinate
    sub cx,y1          ; minus starting y-coordinate
    inc cx             ; plus one
;
; count for inner loop
    mov si,x2          ; ending x-coordinate
    sar si,1           ; divide
    sar si,1           ; by 4
    mov ax,x1          ; starting x-coordinate
    sar ax,1           ; divide
    sar ax,1           ; by 4
    sub si,ax          ; take the difference
;
; get the color
    mov bx,color        ; get the color
```

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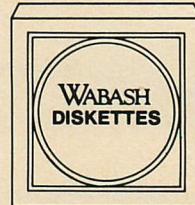
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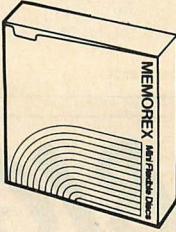
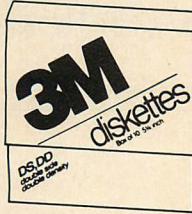
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-----	-----
-----	-----
-----	-----
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-----	-----
-----	-----
-----	-----
-----	-----
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-----	-----
-----	-----
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-----	-----
-----	-----
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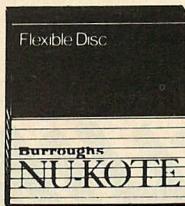
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# GRAPHICS EXCERPT

```

and    bx,3      ; just between 0 and 3
mov    dl,cbytes[bx] ; look up color pattern

;

; determine mask for start and ending bytes
mov    bx,x1      ; starting byte
and    bx,3      ; just the pixel position
sal    bx,1      ; times 2
sal    bx,1      ; times 4
mov    ax,x2      ; ending byte
and    ax,3      ; just the pixel position
add    bx,ax      ; 4*starting+ending
sal    bx,1      ; 8*starting+2*ending
mov    bx,xtable[bx] ; look up the masks

;

; set up masked color bytes
mov    dh,dl      ; color for left bytes
mov    ah,dl      ; color for middle bytes
and    dx,bx      ; mask left and right color bytes
;

cld      ; forward

;

sboxloop:
push   cx      ; save count of outer loop
push   di      ; save initial byte position
;

mov    cx,si      ; count for inner loop
;

; check for only one byte
mov    al,bh      ; get the mask
jcxz  sboxloop2  ; if ending byte coincides
;

; color leftmost byte of the scan line
not    al      ; reverse the mask for clearing
and    al,es:[di] ; get byte from memory and clear pixels
or     al,dh      ; put color in place
stosb

;

; check for just two bytes
dec    cx      ; count the byte
jcxz  sboxloop1  ; done?

```

```

;

; color middle bytes of the scan line
mov    al,ah      ; color for middle bytes
rep    stosb      ; put middle bytes in place

;

; handle rightmost byte of the scan line
;

; come here if two or more bytes
sboxloop1:
mov    al,OFFh    ; set full mask
;

; in any case come here to adjust the masks
sboxloop2:
and    al,b1      ; bring in right part of mask
and    dl,al      ; clear left part of color if needed
;

; color the byte
not    al      ; reverse the mask for clearing
and    al,es:[di] ; get byte from memory and clear pixels
or     al,dl      ; put pixels in the byte
stosb

;

; compute next scan line
pop    di      ; restore address of left side of box
test   di,2000h  ; odd or even line?
jz     sboxloop3 ; skip if even
add    di,80      ; add 80 bytes per line
sboxloop3:
xor    di,2000h  ; changes banks in any case
pop    cx      ; restore count for outer loop
loop   sboxloop  ; next scan line
;

pop    ax      ; restore registers
pop    cx
pop    bx
pop    dx
pop    di
pop    si
ret

;

setbox  endp

```

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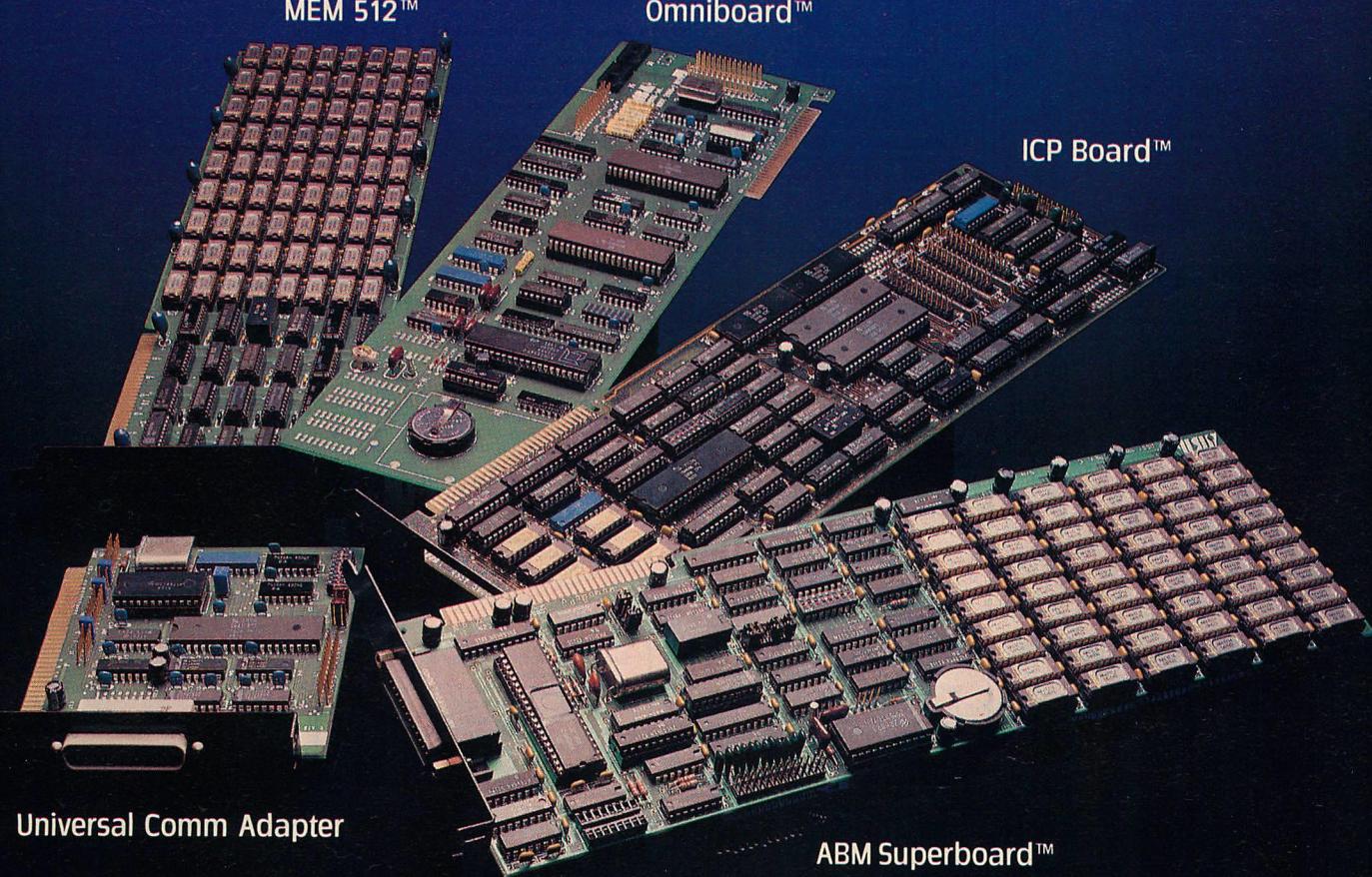


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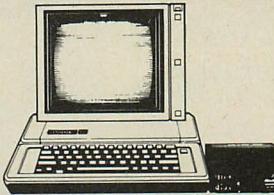
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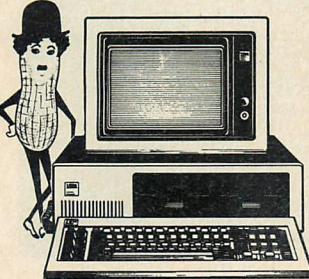
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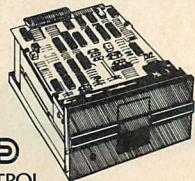
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# GRAPHICS EXCERPT

## LISTING 7 XORBOX—FILL A RECTANGULAR BOX USING XOR

### XORBOX

#### XOR Fill a Rectangular Box with Color

**FUNCTION:** This routine fills a rectangular box in the color graphics screen with a given color using the "exclusive or" operation. Each pixel in the rectangle is colored with a color obtained by "exclusive oring" its original color with a specified color. This function is useful for making cursors.

**INPUT:** Upon entry:

- x-coordinate of upper left corner is in *x1*
- y-coordinate of upper left corner is in *y1*
- x-coordinate of lower right corner is in *x2*
- y-coordinate of lower right corner is in *y2*
- color of the rectangle is in bits 0 and 1 of color

**OUTPUT:** Just to the screen

**REGISTERS USED:** No registers are modified.

**SEGMENTS REFERENCED:** Upon entry ES must point to the video RAM at B8000h and DS must point to the following look-up table for color masks:

xtable

```
dw OFFC0h,0FFF0h,0FFFCh,0FFFFh
dw 03FC0h,03FF0h,03FFCh,03FFFh
dw 00FC0h,00FF0h,00FFCh,00FFFh
dw 003C0h,003F0h,003FCh,003FFh;
```

**ROUTINES CALLED:** None

**SPECIAL NOTES:** No bounds-checking is performed. The coordinates must be in range and in order. That is, the following must be true:

$$0 \leq x1 \leq x2 \leq 319$$

$$0 \leq y1 \leq y2 \leq 199$$

### CODE:

```
; ROUTINE TO XOR A RECTANGULAR BOX
;
xorbox proc far
;
    push    si           ; save registers
    push    di
    push    dx
    push    bx
    push    cx
    push    ax
;
; determine byte position for start
;
; get y contribution
    mov     ax,y1          ; get starting y-coordinate
    mov     ah,al          ; replicate for odd/even bank
    and     ax,1FEh         ; just one bit gets moved
    sal     ax,1             ; times 4
    sal     ax,1             ; times 8
    sal     ax,1             ; times 16
```

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# GRAPHICS EXCERPT

```

        mov  di,ax      ; address gets 16 times y-coordinate
        and di,7FFh    ; not the odd/even bit
        sal  ax,1      ; times 32
        sal  ax,1      ; times 64
        add  di,ax      ; address gets 80 times y-coordinate
;
; add in x contribution
        mov  ax,x1      ; get x-coordinate
        sar  ax,1      ; divide
        sar  ax,1      ; by 4
        add  di,ax      ; beginning offset
;
; count for outer loop
        mov  cx,y2      ; ending y-coordinate
        sub  cx,y1      ; minus starting y-coordinate
        inc  cx          ; plus one
;
; count for inner loop
        mov  si,x2      ; ending x-coordinate
        sar  si,1      ; divide
        sar  si,1      ; by 4
        mov  ax,x1      ; starting x-coordinate
        sar  ax,1      ; divide
        sar  ax,1      ; by 4
        sub  si,ax      ; take the difference
;
; get the color
        mov  bx,color    ; get the color
        and bx,3      ; just between 0 and 3
        mov  dl,cbytes[bx] ; look up color pattern
;
; determine mask for start and ending bytes
        mov  bx,x1      ; starting byte
        and bx,3      ; just the pixel position
        sal  bx,1      ; times 2
        sal  bx,1      ; times 4
        mov  ax,x2      ; ending byte
        and ax,3      ; just the pixel position
        add  bx,ax      ; 4*starting+ending
        sal  bx,1      ; 8*starting+2*ending

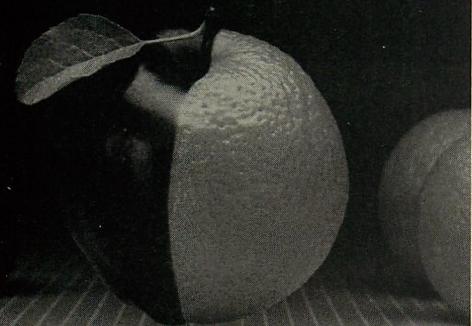
```

```

        mov  bx,xtable[bx] ; look up the masks
;
; set up masked color bytes
        mov  dh,d1      ; color for left bytes
        mov  ah,d1      ; color for middle bytes
        and dx,bx      ; mask left and right color bytes
;
        cld          ; forward direction
;
xboxloop:
        push cx          ; save count for outer loop
        push di          ; save address of leftmost byte
;
        mov  cx,s1      ; count for inner loop
;
; check if only one byte in a scan line
        mov  al,bh      ; get the mask
        jcxz xboxloop3 ; ending byte coincides
;
; xor the leftmost byte
        xor  es:[di],dh ; xor color into memory
        inc  di          ; next byte
        dec  cx          ; count it
        jcxz xboxloop2 ; done?
;
; xor the middle bytes
xboxloop1:
        xor  es:[di],ah ; xor color byte into memory
        inc  di          ; next byte
        loop xboxloop1  ; loop to get all the middle
;
; handle the rightmost byte
;
; come here if two or more bytes
xboxloop2:
        mov  al,0FFh    ; set full mask
;
; in any case come here to adjust
xboxloop3:
        and  al,b1      ; bring in right part

```

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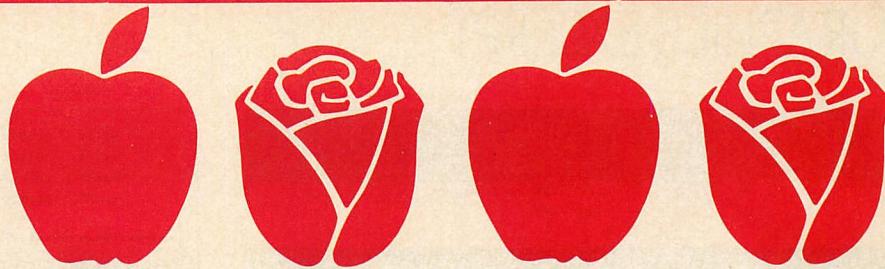
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# GRAPHICS EXCERPT

```

        and    dl,al      ; mask the color if needed
;
; xor the rightmost byte
        xor    es:[di],dl  ; xor byte into memory
        inc    di          ; next byte
;
        pop    di          ; restore the leftmost address
        test   di,2000h    ; odd or even scan line?
        jz    xboxloop4    ; skip if even
        add    di,80        ; add 80 if odd
xboxloop4:
        xor    di,2000h    ; switch banks in any case
        pop    cx          ; restore count of outer loop
        loop   xboxloop    ; loop for next scan line
;
        pop    ax          ; restore registers
        pop    cx
        pop    bx
        pop    dx
        pop    di
        pop    si
        ret
;
xorbox  endp
;
;----- routine ends -----
ex4prim ends      ; end of code segment
;

```

## LISTING 8—CONSTANTS AND DEFINITIONS USED IN SECOND-LEVEL FUNCTIONS

```

;
; For 320 x 200 color graphics mode
;
extrn  setpt:far,xorpt:far,locate:far

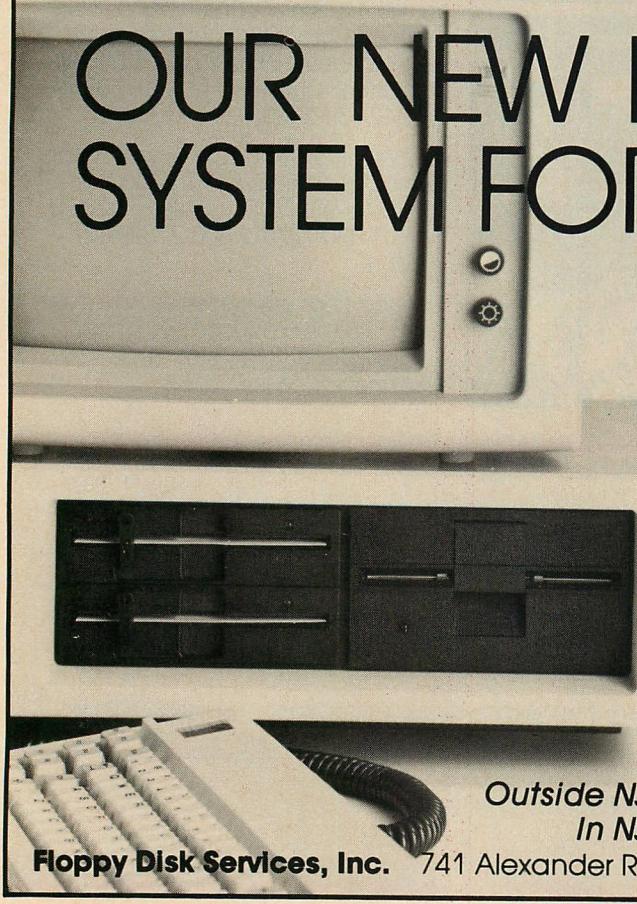
```

```

extrn  setbox:far,xorbox:far
extrn  x0:word,y0:word,x1:word,y1:word,x2:word
extrn  color:word
extrn  ptable:word
;
*****
stacks segment stack
        db    100 dup('paint stack   ')
paintstack  label  word
        db    100 dup('regular stack ')
stacks ends
*****
datas segment public
;
        public font
        public xmagn,ymagn
        public xmess,ymess
;
; public parameters
font    db    0
xmagn  db    1
ymagn  db    1
xmess  dw    ?
ymess  dw    ?
;
; parameters needed for line drawing routine
dels   dw    ?
delp   dw    ?
dele   dw    ?
;
deltas label  word
delsx  dw    ?
delsy  dw    ?
delse  dw    ?
deldx  dw    ?
deldy  dw    ?
delde  dw    ?
;
datas  ends
*****

```

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A hand is shown from the bottom right, holding a large, metallic, three-dimensional Microsoft logo. The logo is dark blue with a metallic texture and a slight shadow, giving it a 3D appearance as if it's floating. The letters 'MICRO' are stacked on top of 'SOFT'.

# GRAPHICS EXCERPT

```

video segment at 0B800h
video ends
;*****
ex4adv segment
;
public gmessout
public setline
public schar,rchar
public paint
;
assume cs:ex4adv,ds:datas,es:video,ss:stacks
;
```

## LISTING 9 SETLINE—DRAW A LINE

### SETLINE

#### Draw a Line

**FUNCTION:** This routine draws a line from (x1,y1) to (x2,y2) in the specified color. It uses Bresenham's algorithm.

**INPUT:** Upon entry:

x1 contains x-coordinate of starting point

y1 contains y-coordinate of starting point

x2 contains x-coordinate of ending point

y2 contains y-coordinate of ending point

color contains the color of the line

**OUTPUT:** Just to the screen

**REGISTERS USED:** No registers are modified.

**SEGMENTS REFERENCED:** Upon entry ES

must point to the video RAM at B8000h and DS must point to a data segment used by the point plotting routine (see SETPT or XORPT above).

### ROUTINES CALLED: SETPT

**SPECIAL NOTES:** No bounds-checking is performed. The user must make sure that the coordinates and the color are in their proper ranges. That is, x1 and x2 must be between 0 and 319, y1 and y2 must be between 0 and 199, and color must be between 0 and 3.

### CODE:

```

; ROUTINE TO DRAW LINE
;
setline proc far
    push bx           ; save registers
    push cx
    push dx
    push si
    push di
    push ax
;
; set up x and y updates
    mov si,1           ; start with positive 1 for x update
    mov di,1           ; start with positive 1 for y updates
;
; find |y2-y1|
    mov dx,y2
    sub dx,y1           ; subtract y1
    jge storey          ; skip if y2-y1 is nonnegative
    neg di             ; move in negative y direction
    neg dx             ; absolute value of y2-y1
;
    storey:
    mov dely,di          ; store y update for diagonal moves
;
```

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Z80: ECOSOFT-Fast, Full	250	225	
8086: C86- optimizer, Meg	399	call	
8086: Lattice - New1.8 & 2.0	600	495	
MicroSoft (Lattice) MSDOS	500	call	
Digital Research - Megabyte	8086	350	280
Desmet by CWare-Fast	8086	109	99

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without SPP	CPM80	350	259	
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ALCOR PASCAL full w/ right extensions to learn	8080	250	call	
SBB PASCAL - great, fast	PCDOS	350	315	
PASCAL 64 - nearly full CPM 64	99	89		
UCSD PASCAL Compiler UCSD-PC	375	call		

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C_to_dBASE - interface	8086/86	NA	\$95
C TOOLS - Graph, Str.	PCDOS	NA	115
FLOAT87 - Latitude, PL1	PCDOS	NA	115
GRAPHGSX-80	CPM80	60	50
HALO	PCDOS	150	125
ISAM Access Manager-86	8086	400	300
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FABS	CPM80	150	135
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SCREEN Display Mgr-86	8086	500	375
PANEL 86 - many	PCDOS	NA	315
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MS FORTRAN 86 - Megabyte	MSDOS	\$350	\$265
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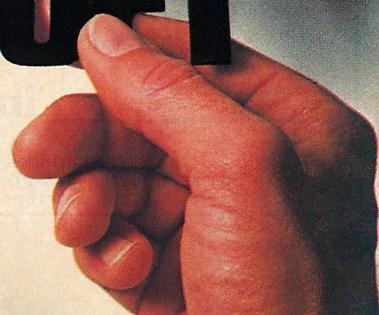
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# GRAPHICS EXCERPT

```

; find |x2-x1|
    mov    cx,x2          ; get x2
    sub    cx,x1          ; subtract x1
    jge    storex          ; skip if x2-x1 is nonnegative
    neg    si              ; move in negative x direction
    neg    cx              ; absolute value of x2-x1

storex:
    mov    deldx,si        ; store x update for diagonal moves
;

; sort |y2-y1| and |x2-x1|
    cmp    cx,dx          ; compare dels with delp
    jge    setdiag          ; skip if straight moves in x direction
    mov    si,0             ; if straight=vertical: kill x update
    xchq   cx,dx          ; and exchange differences
    jmp    storedelsxy

setdiag:
    mov    di,0             ; if straight=horizontal: kill y update

; store dels, delp, delsx, and delsy
storedelsxy:
    mov    dels,cx          ; change in straight direction
    mov    delp,dx          ; change in perpendicular to straight
    mov    delsx,si          ; x update in straight direction
    mov    delsy,di          ; y update in straight direction
;

; get initial values for x and y
    mov    si,x1            ; x-coordinate
    mov    di,y1            ; y-coordinate
;

; compute initial value and increments for error function
    mov    ax,delp
    sal    ax,1             ; 2*delp
    mov    delse,ax          ; change if straight move
;

    sub    ax,cx            ; 2*delp - dels
    mov    bx,ax             ; initial value
;

    sub    ax,cx            ; 2*delp - 2*dels
    mov    delde,ax          ; change if diagonal move
;

```

```

; adjust count
    inc    cx
;

; set the color
    mov    dx,color          ; get the color
;

; main loop structure
lineloop:
    call   setpt             ; plot the point
    cmp    bx,0              ; determine straight or diagonal move
    jge    diagonal
;

; case for straight move
straight:
    add    si,delsx          ; update x
    add    di,delsy          ; update y
    add    bx,delse          ; update error term
    loop   lineloop          ; next point
    jmp    lineexit
;

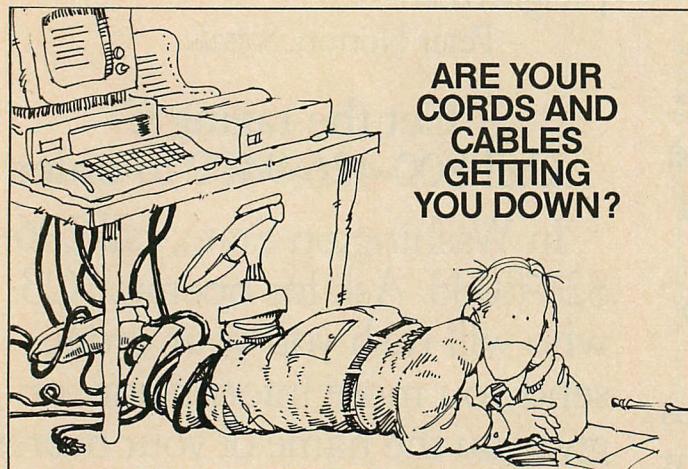
; case for diagonal move
diagonal:
    add    si,deldx          ; update x
    add    di,deldy          ; update y
    add    bx,delde          ; update error term
    loop   lineloop          ; next point
;

lineexit:
    pop    ax                ; restore registers
    pop    di
    pop    si
    pop    dx
    pop    cx
    pop    bx
    ret
;

setline endp
;----- routine ends -----
ex4adv  ends
;----- end of code segment
;

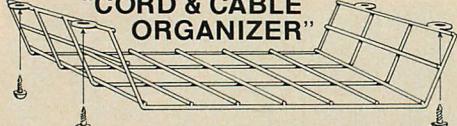
end

```



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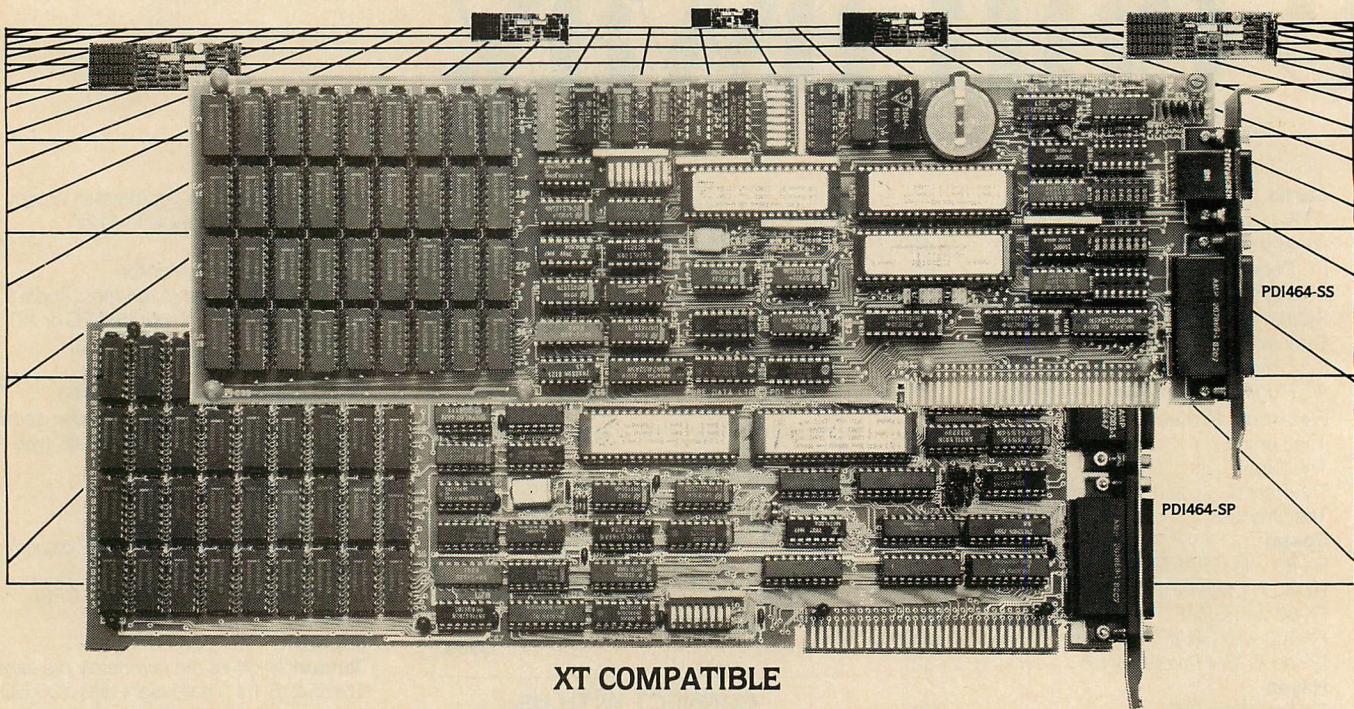
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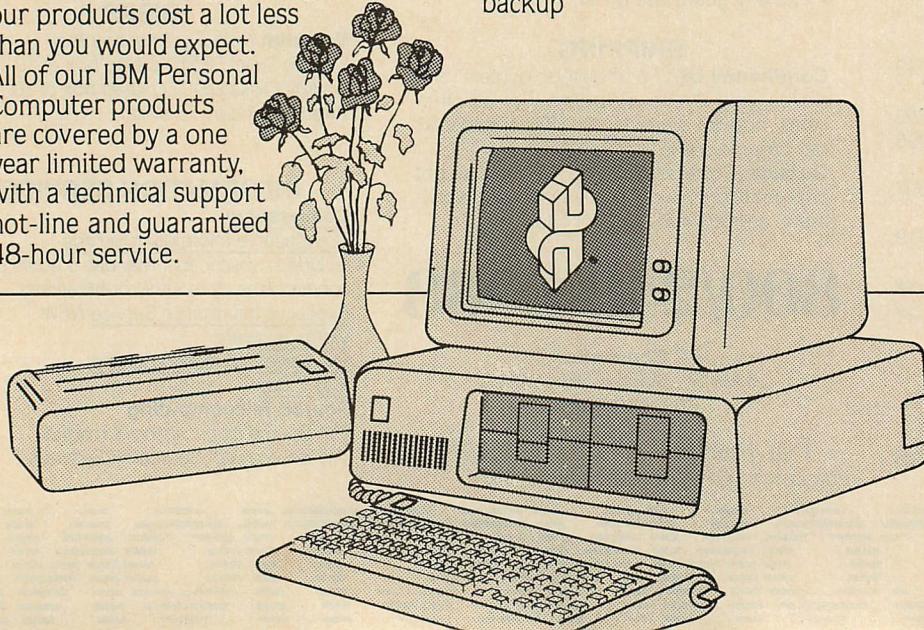
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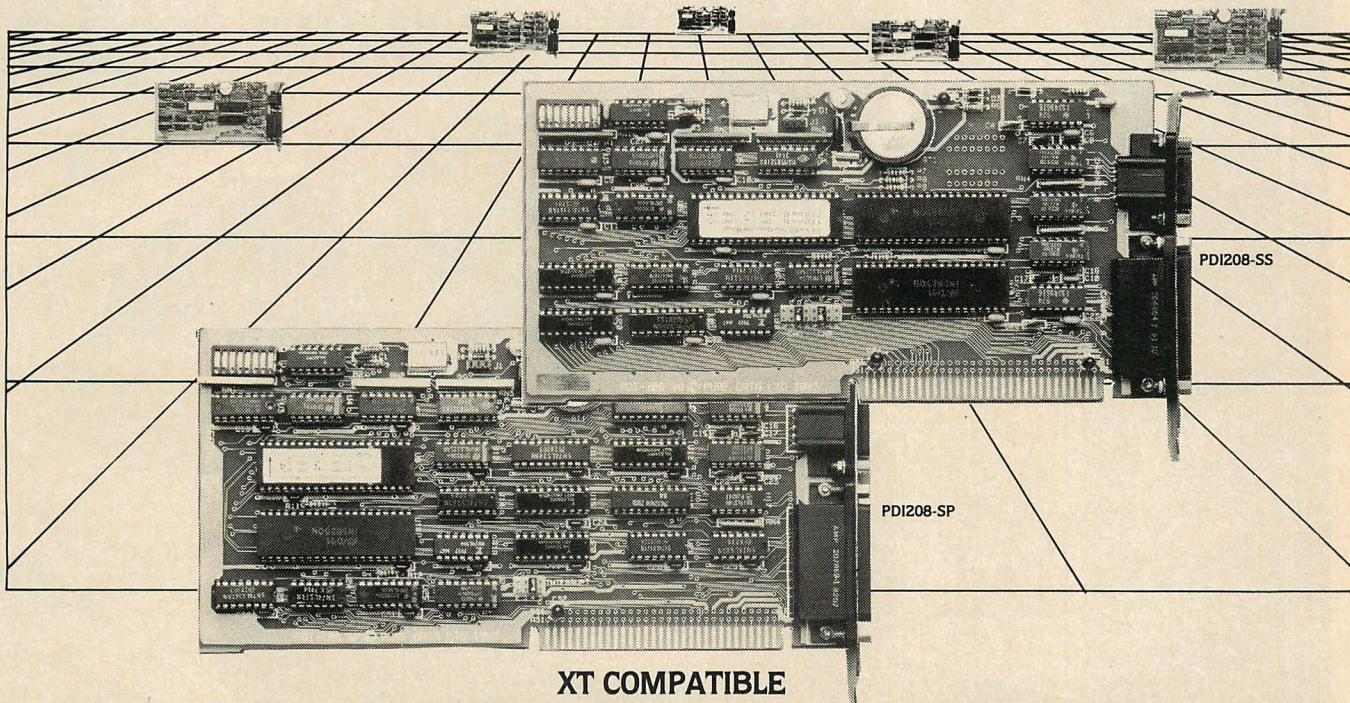
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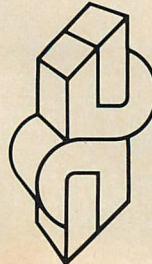
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- Real Time Clock/Calendar with field-replaceable lithium battery backup
- p-Disk™ disk emulator for single/double-sided diskette emulation
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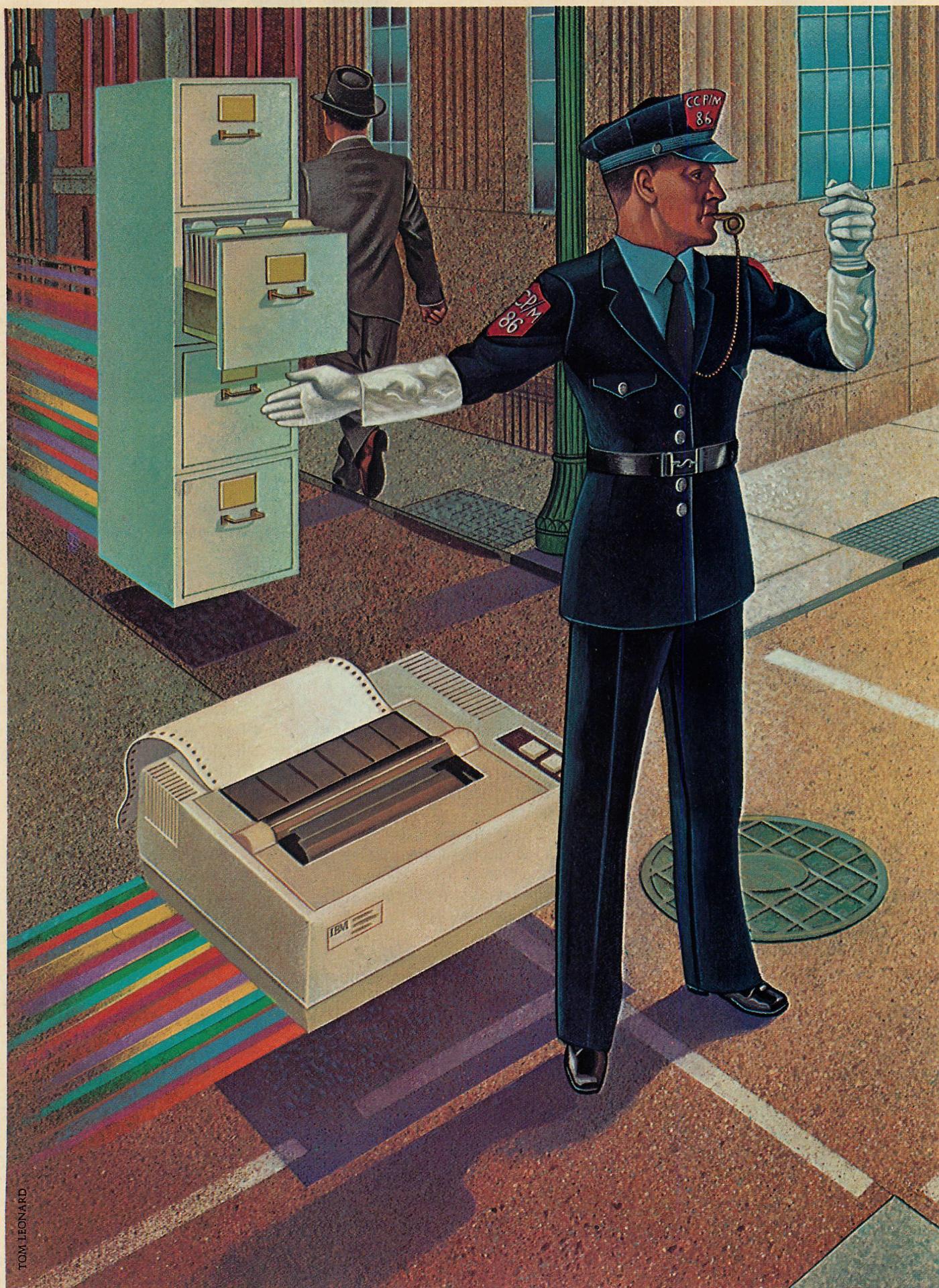
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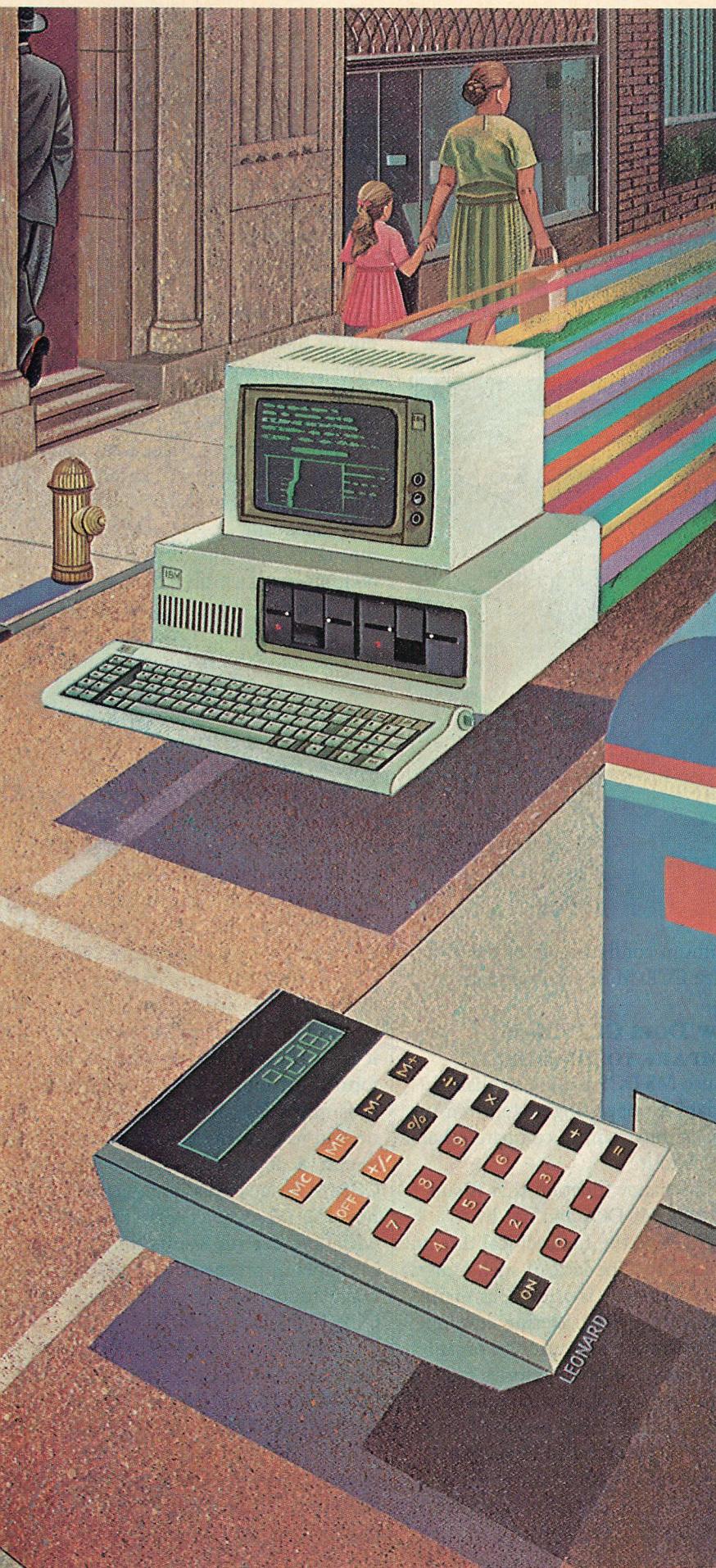
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DON AWALT

# CCP/M-86

*An operating system  
with concurrency: a worthy  
alternative to MS-DOS*

To many users there is only one operating system to use on the IBM PC and PC/XT: MS-DOS, published by Microsoft and sold by IBM as IBM DOS. Although there are several other operating systems for the PC, users are sometimes unaware of their advantages and disadvantages; they may be using MS-DOS when another system would be more appropriate. It is important to know the characteristics of each operating system in order to choose among them.

Concurrent CP/M-86 (CCP/M-86) is an operating system with an architecture both similar to and different from that of MS-DOS. In order to understand the characteristics of this system, it is important to understand something of its history.

## DEVELOPMENT OF CCP/M-86

CCP/M-86 is one of a family of systems developed by Digital Research, Inc. (DRI) from CP/M, a consensus 8-bit operating system (which even today

# CCP/M-86

dominates the 8-bit market). In an effort to provide an evolutionary path for its 8-bit users, DRI followed CP/M with CP/M-86 (the 16-bit version of CP/M), CCP/M-86 (single user, multi-tasking), and MP/M (full multi-user). This family of operating systems is upwardly compatible. Software written for CP/M can be fairly easily upgraded through MP/M.

## WHAT IS CCP/M?

CCP/M-86, a single-user, multi-tasking operating system, seems to possess the best mix of features from all of the Digital Research 16-bit operating systems for the PC. Its ability to perform concurrent or simultaneous operations is not provided by CP/M-86, and although MP/M does provide this ability, that system also possesses multi-user capability, which is not required by most users of PCs.

CCP/M-86 has commands to perform program and data-file storage, retrieval, reporting, error checking, and utility functions. Other common features available are Debug, a pro-

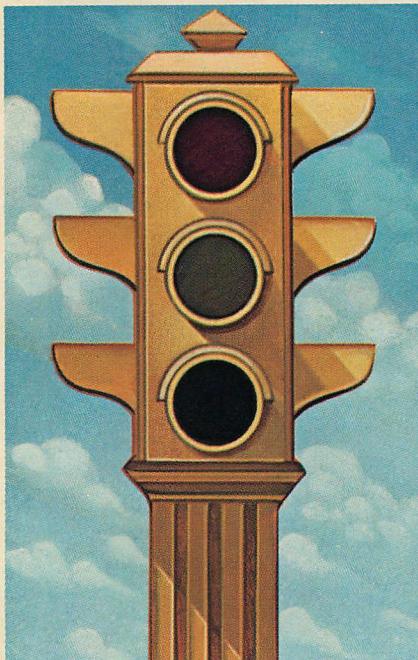
**C**CP/M-86, a single-user, multi-tasking operating system, seems to possess the best mix of features from all of the DR 16-bit operating systems for the PC.

gram editor, and commands to support batch processing.

The full complement of IBM PC peripherals is also supported by CCP/M-86, including monochrome and color displays, diskettes and hard disk drives, and parallel and serial printers. Serial communications are also supported, although special communications software (such as that

needed to operate a modem) is not provided. Most expansion memory and multi-function boards are CCP/M-86 compatible, but some functions (e.g., clock/calendar support) may not run under this system.

CCP/M-86's wealth of features has its price. The size of the basic operating system approaches 96K, and Digital Research recommends a



minimum configuration of 256K to realize CCP/M-86's full potential.

## HOW DOES CCP/M-86 COMPARE TO MS-DOS?

Because MS-DOS is the established standard for operating systems on the PC, it is important to compare other systems to it.

The major function that is supported by MS-DOS and not by CCP/M-86 is the hierarchical directory structure. The lack of such a directory structure is critical, as many sound software-engineering development techniques require the organization provided by directories for controlling source, documentation, test data, object code, and work in progress. The omission of such a structure places constraints on the major development efforts that can be done with CCP/M-86.

Concurrency is the major enhancement of the CCP/M-86 over MS-DOS. Concurrency means that the computer can perform apparently simultaneous operations; in fact, these operations are executed in parallel through efficient use of the computer's resources. A concurrent operating system balances both computing time and waiting time for peripherals (such as printers and disks) so that it can "make progress" on several tasks at once.

An example of concurrent operation on a computer will emphasize the significance of this added feature. If an operating system has concurrent tasks consisting of a Pascal compilation, an assembly language object link, the printing of a VisiCalc file, and a large DBASE II sort, the system will perform the calculation/processing required for the Pascal compile and link, while waiting for a response from the disk on the most recent access for the sort and while waiting for a printer response.

Whenever the currently executing task has to wait for completion of an I/O operation, that task's use of the resource will be initiated by the CPU, the task will be "suspended," and another task will receive the CPU's attention. These tasks are "processes," as defined by DRI.

Even in this simplified example it is clear that the time taken to perform these four processes concurrently is much less than would be needed to perform the processes end-to-end. A detailed description of how CCP/M-86 manages resources and how the PC owner starts, interacts with, and derives results from the simultaneous processes will define the major functional differences between CCP/M-86 and MS-DOS.

CCP/M-86 costs \$350, compared with \$65 for MS-DOS 2.1 and \$60 for CP/M-86. CCP/M-86 includes an assembler, \$100 extra with MS-DOS, yet does not have a BASIC Interpreter (standard with MS-DOS). The \$190 price difference is thus the cost of concurrency.

## SOLID, UNSURPRISING DOCUMENTATION

Any IBM user who purchases Concurrent CP/M-86 will immediately notice the formidable size of the manual. There are actually three manuals provided in one bookcase-type binder: a user's guide, the programmer's guide, and a small supplement that describes operating system commands to format and support a hard disk. Although the size of this documentation is impressive, it does not seem so large when compared to the combined documentation for MS-DOS 2.0 and the Macro Assembler.

The DRI manuals appear to be well written. They lack a discussion of basic real-time or multi-tasking operating-system principles, which would make the use of the CCP/M-86 function calls a lot easier. From my early days of programming real-time systems, I recall that it is easy to understand the operating-system function calls singly, but more difficult to use them together in the proper context.

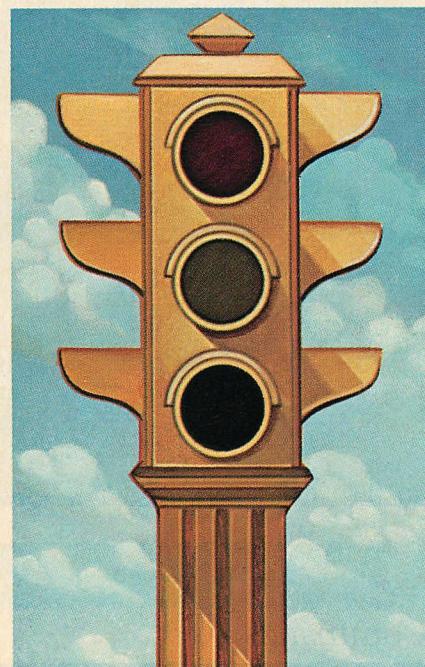
The user's manual describes all of the CP/M-86 commands and includes a description of the Line Editor (ED). This manual is written on a level that a novice can understand and has helpful reproductions of the menu screens with many explanations. CCP/M-86 is a much more menu-driven operating system than MS-DOS, and I think the commands are thus easier to use.

The programmer's guide is the bulk of the documentation; it provides calling sequences for all operating-system function calls (similar to MS-DOS and BIOS function calls). The description of the function calls is good, but the lack of a summary chart for quick reference on a particular function call is noticeable. This manual is long on explanation, but short on reference ability.

Other topics included in the programmer's guide are an operating system overview and detailed descriptions of the debugger and assembly language. These programs are similar

enough to their MS-DOS equivalents that a knowledgeable user would be able to learn the tools easily. There are no surprises in either package.

At the back of the manual, in the traditional plastic protective covers, are three diskettes that contain the software needed to operate CCP/M-86. The first diskette is a boot disk, the second has the majori-



ty of system files (and is appropriately called the System Disk), and the third is an excellent Help Disk. The CCP/M-86 help function is superior; it almost eliminates the need for a user's guide if the user is experienced with MS-DOS or another comparable operating system.

### COMMANDS

CCP/M-86 has several commands that are functionally very close to existing MS-DOS commands (see table 1). It provides an assembler, linker, and editor; a set of useful commands to perform file access and storage; and a list of more minor commands. My comparison of CCP/M-86 and MS-DOS commands implies not that functions are identical, but that they are similar enough to provide a reasonable thumbnail sketch of the capability of CCP/M-86.

**I**t is easy to understand the operating-system function calls singly, but more difficult to use such function calls together in the proper context.

CCP/M-86 is used in a manner similar to MS-DOS. The system is booted (more on this later), and programs are executed. Up to four programs can execute at the same time.

To take advantage of CCP/M-86's concurrent ability, the first operation the user must learn is switching between virtual consoles. This is easy and quick: to switch to virtual console 0, 1, 2, or 3, simply depress the Control key and the appropriate digit on the numeric keypad.

In order to control the simultaneous execution possible with this system, several commands were defined to segregate the different tasks at times when they might improperly interact with each other. These commands, which are not supported by MS-DOS, form the basis for the extended commands found in table 2. An examination of these commands will show that each has a specific function in making the process of simultaneous execution possible.

The USER command comes as close as CCP/M-86 gets to MS-DOS's hierarchical directory structure. Through the USER command, a user number of 0 to 15 is defined; this number is used to logically separate files on each disk drive. Processes can access only files created under the same user number. The DIR and SDIR (directory list) commands will print information only for files created by the appropriate user.

The one exception to this rule is PIP (Peripheral Interchange Program),

# CCP/M-86

**Table 1** CCP/M-86 Commands that have MS-DOS Counterparts

CCP/M-86 Command	Similar MS-DOS Command
ABORT	(like CTRL-BRK)
ASM86	(MASM)
CONFIG	MODE
DDT86	DEBUG
DIR	DIR
DSKMAINT	DISKCOPY/FORMAT/ DISKCOMP
ED	EDLIN
ERA	ERASE/DEL
ERAQ	DEL/ERASE (with verify)
FUNCTION	keyboard reassignment
GENCMD	LINK
HDMAINT	FDISK
PIP	COPY/DISKCOPY/ BACKUP/RESTORE
REN	REN
SDIR	DIR
SET	(includes VERIFY)
SHOW	CHKDSK
SUBMIT	execute batch file
TOD	DATE/TIME
TYPE	TYPE

**Table 2** Other CCP/M-86 Commands

CCP/M-86 Command	Function
DSKRESET	Logs out all specified drives
HELP	Explanations of all commands
PRINTER	Displays assigned printer number
STAT	Displays file info; sets file attributes
SYSDISK	Assigns a system diskette
USER	Sets user number
VCMODE	Defines mode of a virtual console

which can cross user boundaries to access any file on a given disk. PIP is a general-purpose program that transfers data between any combination of files and hardware peripherals.

Several other commands exist under CCP/M-86 to assign resources, including printers or files, to specific users. The "management" of these resources is aided by the use of the PRINTER, STAT, SET, DSKRESET,

and SYSDISK commands.

PRINTER is used to assign a default printer to a specific console. Although several consoles can use the same default printer, only one process can use the printer at a time.

STAT can be used to display information about diskette drives and files; its more powerful feature, however, is the ability to change and set file attributes to protect and organize

disk files. Files can be set with read-only status, read-write, SYS, and DIR attributes. These attributes cannot be arbitrarily mixed; a file can be either read-only or read-write and either a SYS file or a DIR file.

Read-only files cannot be updated or deleted, whereas read-write files can be used for any type of file access. SYS and DIR specify the organizational type of the file. SYS specifies that the file is a system file, and its file status appears only as a result of the SDIR command; DIR specifies that the file is a directory or data file, and its status is reported only with the DIR command.

Using STAT to separate data and system files is a key organizational tool under CCP/M-86, since no hierarchical directory structure exists. Because all operating-system software is designated SYS, a programmer using the DIR command will see only information about user files.

The SET command performs the same attribute-setting functions as STAT and also provides password protection and time-stamping capabilities at the diskette-drive level. If SET is used, any files on a given drive will require the use of a proper password for file access to be granted.

Password protection is a powerful feature and (like SET itself) can be used to limit the access to system files or programs. SET actually "turns on" the password capability; individual files may have individual passwords assigned. Take care to remember the passwords, however.

Password protection can be used to define one of three protection types: it can prevent any read or write commands to the file, it can permit any file access except a delete command, or it can permit only reading of the file.

The last two commands unique to CCP/M-86 are helpful for managing the disk as a resource. SYSDISK is used to assign a system drive; this is useful when running batch programs (via the SUBMIT command). DSKRESET is used to log out one or

more disk drives. Logging out a drive enables the logical removal of a diskette or removable hard disk from the system; it insures no other processes are using the drive (since the log-out will fail in that case).

### STRUCTURAL EFFECTS OF CONCURRENCY

To better understand the impact of concurrency on an operating system, we will look at the organization of CCP/M-86's software.

Figure 1 shows the different parts of what is referred to as the "resident" portion of CCP/M-86. The resident portion exists in memory at all times and is differentiated from any user programs or operating system programs (like the debugger or line editor), which normally reside on the disk until called upon to execute. This second group of programs forms the "transient" portion of CCP/M-86.

**Supervisor.** The first logical module contained within the CCP/M-86 operating system is the Supervisor. The Supervisor is a software set that performs initial processing of all function calls (the term *function call* is used in the same way as it is in MS-DOS); it also performs all of the processing for some of the less complicated function calls.

The Supervisor can best be thought of as the "hub" of the activity within CCP/M-86. It passes control to the software programs that resolve contention between competing resources, provides a direct interface with hardware, and provides software for basic I/O functions (similar to MS-DOS "BIOS"). The Supervisor can be compared to the highest-level routine in a structured program.

**Real Time Monitor.** The next major component of the CCP/M-86 operating system is the Real Time Monitor. This provides the nucleus of all the multi-tasking, multi-process functions, producing most of the system's concurrent functionality.

The Real Time Monitor manages requests for the resources of the com-

puter from the various processes running under CCP/M-86. The resources to be shared may include hardware, software, or uniquely defined processes—in short, any hardware or software that more than one process may wish to use simultaneously.

Another task performed by the Real Time Monitor is the allocation of the CPU time across all competing processes. A brief explanation of this allocation will help to clarify the concept. For a more detailed description, a book on operating systems principles is recommended.

**T**he Real Time Monitor provides the nucleus of all the multi-tasking, multi-process functions. It produces most of the concurrent functionality of CCP/M-86.

In a single-task system like MS-DOS, most tasks are done sequentially, i.e., one at a time. Sequential execution is actually very inefficient for the computer, as much time is wasted: waiting for keyboard input, waiting for completion of a disk read, waiting for the completion of printing, etc. In a multi-tasking system, the computer will not wait if it can execute a process instead. To do this efficiently and to insure that all processes get a fair chance to execute, a dispatching algorithm is needed.

The purpose of the dispatching algorithm is to give the operating system a way in which to decide which process should execute. If no process is bidding for execution time, then a "null" process executes. This null

process does nothing of significance; it might count from zero to 65,535 and start over, or calculate PI to a thousand decimal places, or just JUMP between two labels. As soon as another process is ready to execute, the null process will be suspended.

If more than one process is ready to execute, the dispatch algorithm will select the process that has the highest assigned priority. Priorities are assigned to each process when that process is created; the more critical or time-sensitive processes are assigned the highest priorities.

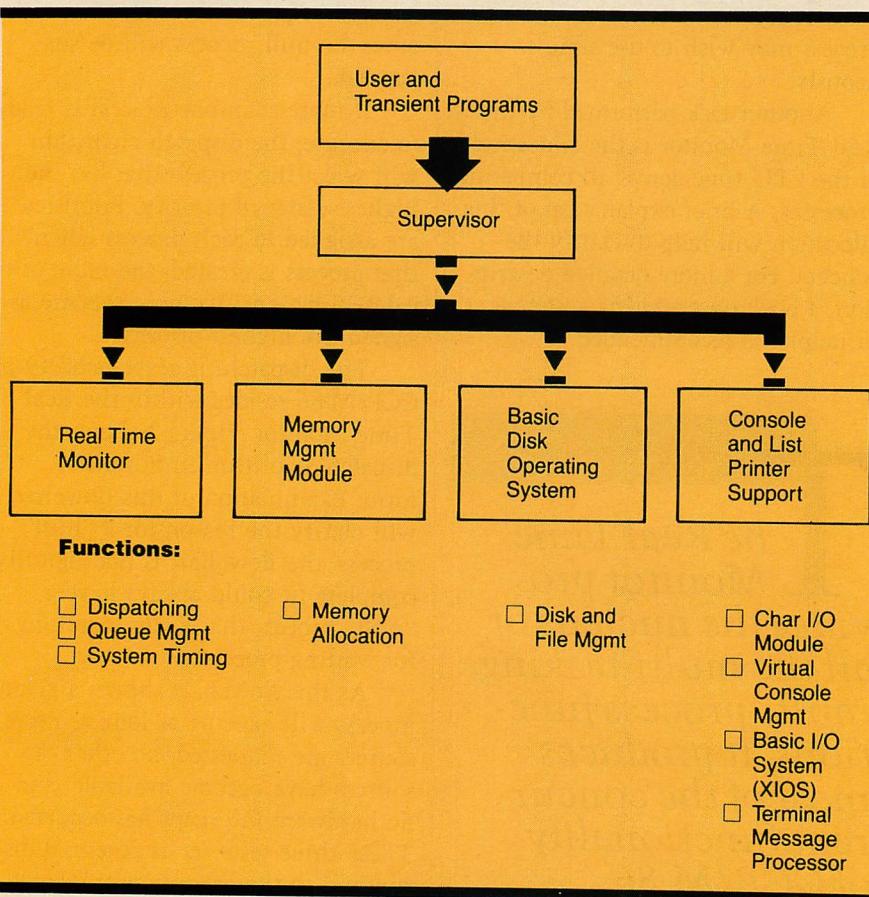
The dispatching responsibility in CCP/M-86 resides within the Real Time Monitor. Figure 2 shows the dispatch algorithm in flowchart form. Examination of this flowchart will clarify the reason for a "null" process: the flowchart is not logically complete (it could always have a "null" process that keeps searching for waiting processes).

As this flowchart shows, a given process will execute as long as no resources are requested, no other resources have become available, and no hardware interrupt has occurred. These three tests act as potential disruptions to the execution of a given process, insuring regular and timely executions for other processes.

The dispatch algorithm must also prevent poor system throughput when a process becomes "CPU bound." A process that is CPU bound does very little I/O and requires only the CPU in order to execute; no other hardware or processes are needed. The CPU-bound process gets a large percentage of the CPU's available execution time, because it is usually through I/O calls that the Real Time Monitor regains control.

The dispatch algorithm minimizes the impact of a CPU-bound process on the system's performance by utilizing an interrupt that occurs in a regular, but short, time interval. In CCP/M-86, an interrupt will occur from the system clock every sixteen milliseconds, limiting the conse-

**Figure 1** Diagram of Concurrent CP/M-86 Resident Software



cutive execution time that any one process can receive. After the interrupt, the system will move on to the next processing task on the list of priorities.

Another major function of the Real Time Monitor is its responsibility for the creation and management of the operating system's queues. Besides fathoming the world's only English word with five consecutive vowels—queueing—queues provide another technique for establishing communications between processes and therefore open up another set of multi-tasking capabilities.

Once techniques have been established for interprocess communication, the creative programmer can synchronize processes based on the results of another process.

Let's look at how queues can be used to synchronize processes. Assume for a moment that process A can execute up to a point, at which a particular output from process B is required. If these tasks were programmed under a single-task operating system, the two processes would have to be combined into one sequential operation, a much less efficient operation. Even in a multi-tasking operation that provides no event synchronization, these processes could not function independently.

At the point at which process A must wait until an event within process B is completed, process A uses a CCP/M-86 command to "read from" a specific queue that is jointly recognized by A and B. At the point at which the particular event within B

is completed, B "writes to" the same queue. The operation of a queue read/write insures that if A reads before B writes, A will be suspended (execution will temporarily cease) until B writes. If A reads after B writes, the execution of A continues. The queueing process has therefore synchronized A and B.

Queues can be used in other applications as well. For example, they can limit the execution of a subroutine to one process at a time (making it non-interruptible) or they can manage contention for a disk drive on a first-come, first-served basis.

As if the different functions of resource management, CPU allocation, and queue management were not enough, the Real Time Monitor provides several other functions that involve the use of the system clock. The maintenance of the time-of-day clock and a function call to delay a process for a specified number of clock "ticks" (16 milliseconds per tick) are provided. Through the use of these routines, a programmer can suspend execution of a process until a specific time of day.

**Memory Module.** The Memory Module (MEM) provides a set of functions that give a programmer a block of memory for use at the time of program execution (as opposed to at the time of compilation).

Memory management functions are implemented in CCP/M-86 to discourage the definition of data areas within every program and to promote the use of "requests" for memory for data storage when a process is actually running. This can result in substantial memory savings for larger systems, as programs that are not running have little wasted data area.

The specific functions available through MEM are allocating and freeing a requested amount of memory, allocating memory at a specific memory address, and allocating the maximum amount of memory available in the system. There are also several corresponding "free memory" functions, used to release memory

previously allocated.

### Basic Disk Operating System (BDOS).

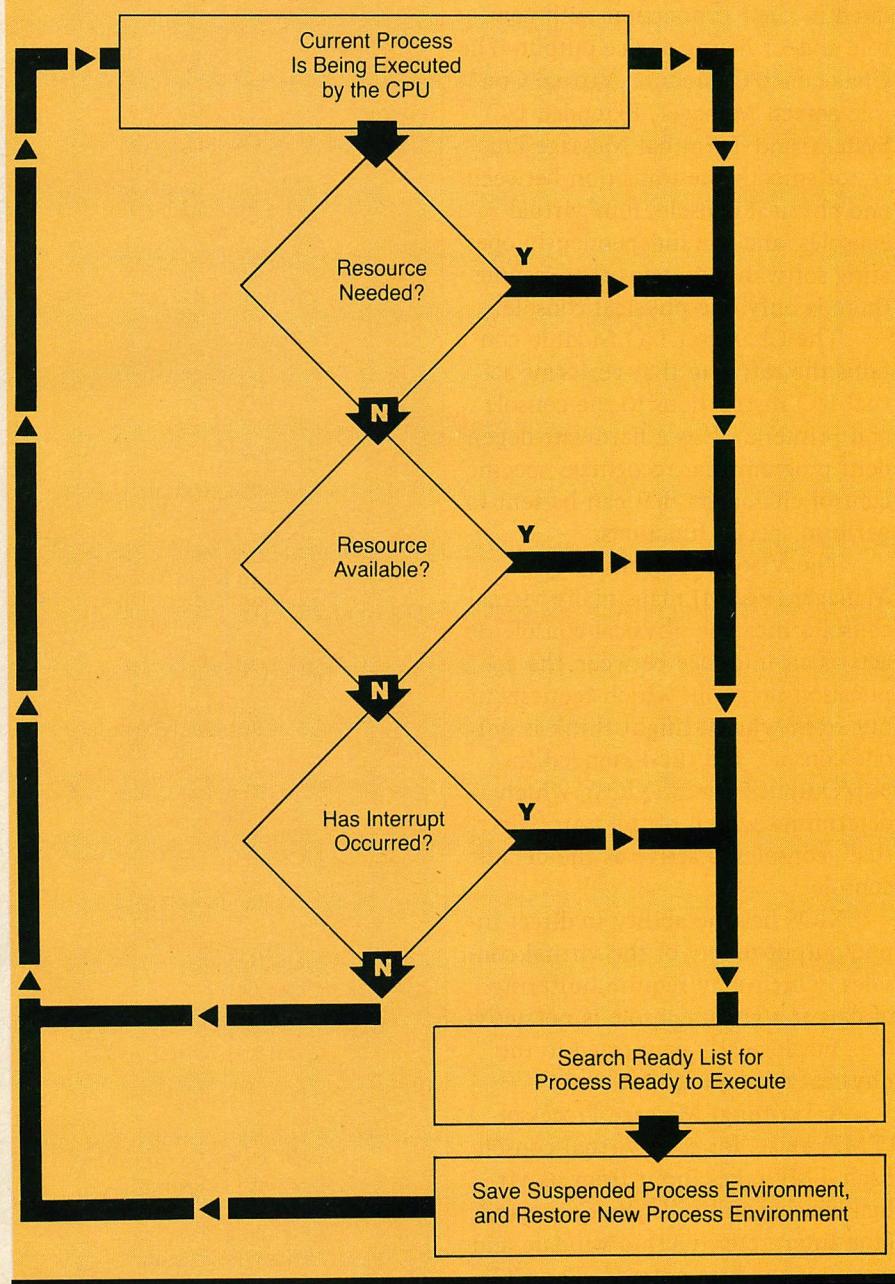
The next part of CCP/M-86, BDOS, is most commonly identified as the "main function" of a disk operating system. BDOS handles a large number of disk and file functions, such as file creation, deletion, and management of disk space. It also manages information pertaining to each file (this information is similar to the information found in the MS-DOS file directories and file-allocation tables) and can build and maintain files in different organizational formats.

BDOS is upwardly-compatible with the BDOS found in CP/M-86, which means that files created under CP/M-86 can be successfully read under CCP/M-86. Concurrent BDOS does have some functions that are specific to this multi-tasking operating system, however, such as file locking, shared access files, and password protection. These features are interesting because they provide an extension to BDOS not available under MS-DOS.

File locking and shared access provide two methods for protecting file integrity in a multi-tasking environment. This protection is necessary, since there is no other mechanism available to insure that files are not simultaneously used by multiple processes. File locking prohibits the use of a file by any process other than that which opened the file in "locked" format, while shared access files can be used simultaneously by more than one process.

If a file is opened with shared access, many processes can access the file simultaneously, but no two processes can access the same logical record at the same time. This feature is known as "record locking," and it prevents a disaster like the following: process A reads a record, process B reads the same record, process B writes the record with new data, and process A writes the record with a different set of new data, losing the data written by process B. Under

Figure 2 Dispatch Algorithm, CCP/M-86



CCP/M-86, the first access by A locks the record until A writes that record with new data.

Other BDOS features that enhance concurrency are date stamping and password protection. Date stamping can provide an excellent record of the date of creation and date of last update, and these dates can be

accessed by application programs. Password protection is a feature that is used to protect sensitive files from access by unauthorized programs. The proper password must be provided by a program (through a CCP/M-86 function call) in order for that program to access a file that has been protected with a password.

**Character I/O Module, Virtual Console Screen Manager, Extended I/O System, and Terminal Message Processor.** These modules are interrelated in their connection with console and/or listing device output. The Character I/O Module, Virtual Console Screen Manager, Extended I/O System, and Terminal Message Processor smooth the transition between one physical console, four virtual consoles, and the independently operating software programs that assume there is only one physical console.

The Character I/O Module contains the software that performs actual I/O instructions to the console and printer(s). It is a hardware-dependent program that recognizes specific control characters that can be sent to perform special functions.

The Virtual Console Screen Manager (VCSM) maps many virtual consoles into one physical console. It acts as an interface between the application program, which requests input from what it might think is only one console, and the Extended Input/Output System (XIOS), which determines which of the four "virtual" consoles is active as the default console.

XIOS has the ability to direct input/output to any of the virtual consoles, which may require buffering of data if a given console is not active (i.e., not logically connected to the physical display) at that time.

A Terminal Message Processor (TMP) exists for each virtual console. Each TMP takes input from its virtual console and calls the Command Line Interpreter (CLI) to validate and interpret the data entered. The CLI determines what command the user wishes to invoke and passes this information to the supervisor for initiation of the proper CCP/M-86 routine. The TMP is the module responsible for maintaining the environment of each virtual console, such as which default disk is being used, what the user number is, and which printers or consoles are being used.

**Table 3 CCP/M-86 Function Calls**

FCN #	Name	Description
0	System Reset	Terminate a process
1	Virtual Console Input	Read a character from Virtual Console
2	Virtual Console Output	Write character to Virtual Console
3	Raw Console Input	Same as #1; No Echo, No Ctrl-C type checking
4	Raw Console Output	Same as #2; No Ctrl-C checking
5	List Output	Output to default list device
6	Direct Console I/O	Do Direct I/O with default virtual console
7	Not Implemented in CCP/M-86	
8	Not Implemented in CCP/M-86	
9	Print String	Print ASCII string
10	Read Console Buffer	Read an Edited input line
11	Console Status	Status of input at Virtual Console
12	Return BDOS Ver Number	Returns 8080 or 8086 type, and CP/M type (CCP/M-86, MP/M, etc.)
13	Reset Disk	All drives set to Read-Write, Default is A
14	Select Disk	Set default disk
15	Open File	Activate an existing disk file
16	Close File	Close a disk file
17	Search for First	Get first file matching name in FCB
18	Search for Next	Find the next matching filename
19	Delete File	Delete a disk file
20	Read Sequential	Get next sequential record from disk file
21	Write Sequential	Write next sequential record to disk file
22	Make File	Create a disk file
23	Rename File	Rename a disk file
24	Return Login Vector	Return info on logged-in disk drives
25	Return Current Disk	Return Default disk number
26	Set DMA Offset	Define memory address for DMA operations with disk
27	Get Addr [Alloc]	Similar to getting File Allocation Vector info under MS-DOS
28	Write Protect Disk	Permit Read only of disk
29	Get Read Only Vector	Return drive nos. of read-only disks
30	Set File Attributes	Define type of file, and read-only status
31	Get Addr [Disk Params]	Get address of Disk Parameters block
32	Set/Get User Code	Get/Change the process default user code
33	Read Random	Read a random record from a disk file
34	Write Random	Write a random record to a disk file
35	Compute File Size	Return number of records present (sequential) or allocated (random) in a disk file
36	Set Random Record	After sequential read/write, return random record number of next record in file
37	Reset Drive	"Reset disk" (fcn 13) for specified drive
38	Access Drive	Opens file and locks drive as open
39	Free Drive	Unlocks drive and permits reset
40	Write Random w/Zero Fill	Write a random record, zero fill previously unallocated records
41	Test and Write Record	Verify contents of current record in memory before write
42	Lock Record	Prevent access by other processes in shared file
43	Unlock Record	Permit access of record by other processes
44	Set Multi-Sector Count	Set logical block size (in sectors) of a record
45	Set BDOS Error Mode	Define manner in which operating system-detected errors should be reported
46	Get Free Disk Space	Return amount of free space on disk drive
47	Chain to Program	Similar to chaining in BASIC
48	Flush Buffers	This forces the writing of any records in memory that are pending write
49	Not supported in CCP/M-86	
50	Direct BIOS Call	Do I/O with character routines in BIOS
51	Set DMA Base	Define DMA memory address for disk I/O
52	Get DMA Address	Get memory address of DMA buffer
53	Get Max Mem	Allocate the maximum memory available to this process
54	Get Abs Max	Allocate the maximum contiguous memory available at given starting address
55	Allocate Memory	Allocate memory to a given process
56	Allocate Abs Mem	Allocate memory starting at given address
57	Free Mem	Free memory for use by another process

58	Free All Mem	Free all memory assigned to process
59	Program Load	Load a .CMD program into memory
100	Set Directory Label	Create or update the directory for the specified disk drive
101	Return Directory Label	Return information about the directory for the specified drive
102	Read File XFCB	Return the extended file control block for the specified disk file
103	Write File XFCB	Create new XFCB or update existing XFCB
104	Set Date and Time	Set system date and time
105	Get Date and Time	Return the system date and time
106	Set Default Password	Define the password a process will use to access password-protected files
107	Return Serial Number	Return the system serial number
128	Memory Allocation	Allocate a memory segment
129	Memory Allocation	Same as function number 128
130	Memory Free	Free memory segment
131	Poll Device	Returns up/down status for non-interrupt-driven devices
132	Flag Wait	Suspend process execution until specified flag interrupts
133	Flag Set	Cause logical interrupt of specified flag
134	Make Queue	Define a system queue
135	Open Queue	Permit read/write operations on a queue
136	Delete Queue	Remove queue from system
137	Read Queue	Read the next message from a system queue; wait if no message
138	Conditional Read Queue	Read queue; return error code if no message
139	Write Queue	Write a message to a system queue; if the queue is full, wait until space is available
140	Conditional Write Queue	Write a queue message; if the queue is full, an error is returned
141	Delay	Suspend execution of process for a specified number of clock ticks
142	Dispatch	Call system dispatch to suspend calling process, and schedule another process
143	Terminate	Terminate the calling process
144	Create a Process	Create subprocess in same memory area
145	Set Priority	Set system priority of calling process
146	Attach Console	Assign exclusive use of the default virtual console to the calling process
147	Detach Console	Permit use of the default virtual console by other processes
148	Set Console	Define the calling process's default virtual console
149	Assign Console	Assign default virtual console to new process
150	Command Line Interpreter	Invoke CLI to read, interpret, and execute an ASCII line from the console
151	Call RPL	Call an operating system library function (Resident Procedure Library)
152	Parse Filename	Interpret an ASCII filename and initialize a file control block
153	Get console	Return the calling process's default virtual console
154	Get Sysdat Address	Return the address of the system data area
155	Get Date and Time	Get current system time and day
156	Return PD Address	Get the address of the calling process's Process Descriptor
157	Abort Specified Process	Terminate a process
158	Attach List	Disallow use of the default list device by other processes
159	Detach List	Free use of default list device
160	Set List	Define the process's default list device; wait if not available
161	Conditional Attach List	Define the process's default list device; return error code if not available
162	Condit'l Attach Console	Attempt to exclusively use the default virtual console; error if unavailable
163	CCP/M Version Number	Return operating system version number
164	Get List Number	Return the calling process's default list device

## A COMPLETE SET OF FUNCTION CALLS

We have already discussed several of the function calls available to the programmer under CCP/M-86. Table 3 gives a summary of all the CCP/M-86 function calls.

The entire set of function calls can be logically grouped into several areas. First, a set of console support calls provides different types of I/O to the default console. Second, an ex-

**M**ulti-tasking functions are provided throughout the collection of function calls. These functions define the concurrency of the system.

tensive list of disk and file function calls provides for file opening, file closing, attribute setting, sequential and random file accessing, and some lower-level functions that can change the parameters used by CCP/M-86 in performing disk I/O.

Finally, the last identifiable group of function calls provides some of the functions we discussed when examining the Real Time Monitor. The dispatch algorithm can be called via a function call, and the user can perform waits for a specified period of time, can perform waits for a specific flag (or event) to be done, and can read and write queues.

Multi-tasking functions are provided throughout the collection of function calls. These are functions that define the concurrency of the system, and they include such calls as password setting, memory allocation, and the locking of a console, printer, drive, file, or record.

There is even a function call to

access the data stored by CCP/M-86 about each process; this data describes the "environment" of the process and is used whenever the system starts or suspends execution of a process. The environment keeps the latest values of the machine registers and system pointers when a process is suspended and restores these values before the process resumes execution. This data can be directly accessed by the enterprising programmer.

An observant reader might notice that there seems to be some redundancy in some of the functions provided by CCP/M-86. This is in fact true, and there is a reason for it.

Some functions were enhanced or modified in the transition from earlier CP/M systems to CCP/M-86. The redundancy of functions in CCP/M-86 is caused by the presence of both the CP/M-86 and the CCP/M-86 functions. To the casual observer, functions may appear identical, but they are not.

Because both function calls are provided, CP/M-86 programs can use its usual function calls and can run without modification under CCP/M-86. New software can use the newer, slightly refined, concurrent function calls. This trick is also used in MS-DOS 2.0 to provide compatibility with version 1.1.

## FILE STRUCTURES

There are three major file structures: the File Control Block (FCB), the Extended File Control Block (XFCB), and the Directory Label. These structures are used to define and manage a specific file under CCP/M-86.

The FCB defines the name, drive, and other specific information about the file. The XFCB and Directory Label perform a similar function in providing password and timestamping information, but the XFCB is at the file level and the Directory Label is at the drive level.

To understand these file structures, we must understand the file limits of CCP/M-86. CCP/M-86's

BDOS supports up to sixteen logical drives. Each drive is divided into two areas: a file area called the directory and a data area associated with the files of that disk. Up to sixteen separate users can have files in a given directory. However, access to these files is mostly limited to the user group that created the file.

Each filename in CCP/M-86 is eight characters, with a three-character extension. In some function calls the "?" designation can be used as a "wildcard" specifier that replaces a given character in the filename.

Each disk file can be up to 256K records, each of a length of 128 bytes.

**B**ecause function calls from both CP/M and CCP/M-86 are given, CP/M-86 programs can use their usual function calls to run without modification under CCP/M-86. New software can use the new, slightly refined, concurrent function calls.

Before you reach for your calculator, that comes to a maximum size of 32 megabytes. One day, we will have disks that large on our PCs . . . .

The FCB is a maximum of 36 bytes long. The first 12 bytes must be supplied by the user when the file is created; the rest are either supplied by the BDOS or used for storage as the file is used.

The first 12 bytes consist of a disk-drive code (1 byte: 0 is the default disk, 1-16 identify a specific disk drive), filename (8 characters), and file extension (3 characters).

The remainder of the FCB in-

cludes an extent number and record count within the extent, an FCB checksum value, the current record number for sequential operations, and an 18-bit value that specifies an optional random record number (approximately 0-256K). These fields are used in maintaining the file.

The FCB checksum is a new feature in CCP/M-86, and it makes tampering with the contents of the FCB much more difficult. The checksum insures the integrity of the FCB before each file access.

Extent numbers define a logical division of the file and are used in conjunction with the record-number field within the FCB to keep a "bookmark" that points to the last record accessed. These fields, plus the sequential and random record-number fields, provide the on-going status that BDOS requires to keep its "place" within the file.

The XFCB and Directory Label have very similar structures. The XFCB has a drive designation, filename, and file type, while the Directory Label has a drive designation, directory name, and directory type. These structures define the password protection required at the file and directory (drive) levels, respectively, and the password protection can be defined as no access, read-only access, and non-delete access.

The XFCB and directory labels also define the password in effect at the file or directory level and the current time stamp, based on the time stamping option specified. Time stamping can be done for each access or for each update, and there is room for time stamps for each type.

## FLEXIBLE ERROR-HANDLING METHODS

BDOS error-handling has a flexibility that is not as obvious under MS-DOS. Under CCP/M-86, BDOS errors can be handled in one of three ways, depending upon the option set by the programmer using function call 45 (Set BDOS Error Mode).

The first method is the way in

which the majority of errors are processed by default, and that is simply to return an error code in the AX register. In this way, the error can be handled at the applications level.

The second and third types of error-handling are more serious, and they define the handling of such errors as Bad Sector, Bad Disk, Read-Only Disk, File Already Opened, FCB Checksum Error, Password Error, File Exists, Maximum Number of Open Files Exceeded, and System Lock List Full. The second error-handling type causes BDOS to display an error message on the console and to abort the offending program, while the third type displays a message on the console screen, but returns an error message in register AX (similar to the way the first type operates). The programmer has full flexibility in defining the mode most desired.

## HOW TO USE CCP/M-86 ON A HARD DISK

CCP/M-86 boots and runs in a straightforward fashion on a diskette-based system, but CCP/M-86 on an IBM PC-XT is more complicated. However, with a little work, a PC-XT can support MS-DOS and CCP/M-86 simultaneously, which provides maximum flexibility for the user.

Putting CCP/M-86 on a hard disk that already supports MS-DOS 2.0 can be quite a problem if the entire disk is partitioned as MS-DOS area. If this is true, a lot of work is necessary in order to make room for CCP/M-86, but the work is time consuming rather than difficult.

The basic theory behind the co-existence of MS-DOS and CCP/M-86 is to create mutually exclusive, contiguous partitions on the hard disk. For my experiments, I assigned the first 255 cylinders to MS-DOS, since 99 percent of my software runs under MS-DOS, and I assigned 50 cylinders to CCP/M-86. This assignment provides some expansion for future CCP/M-86 software acquisitions, as CCP/M-86 requires a minimum of ten cylinders to operate.

In order to create room for CCP/M-86, the entire MS-DOS hard-disk partition should be backed up. Use the backup command

### BACKUP C:/ A:/S

to backup all files and directories to diskette. Be forewarned, however—this could take up to *twenty-nine* diskettes for a full (10 megabyte) disk.

After the MS-DOS files are safely backed up, FDISK must be invoked under MS-DOS to delete the MS-DOS partition and create a new (smaller) partition. After the new (empty) partition is created, invoke the MS-DOS FORMAT command (using the /S switch to copy MS-DOS onto the hard disk) to reformat the hard disk.

Be very careful to insure the /S option is included in the FORMAT command line. Without it, MS-DOS cannot boot from the hard disk, and it will be necessary to start the process again. This will involve deleting any files transferred to the hard disk and then transferring MS-DOS again, since the MS-DOS boot programs must reside *first* in the root directory of the hard disk.

After the formatting of the hard disk is completed, restore the files that were backed up by using the command

### RESTORE A: C://S

At the completion of this (hopefully not too long) exercise, MS-DOS occupies a smaller partition, leaving room on the hard disk for CCP/M-86.

CCP/M-86 has a program similar to FDISK; it is called HDMAINT. This is the program that will be used to create, modify, and delete CCP/M-86 partitions on a hard disk.

After booting CCP/M-86 from diskette, invoke HDMAINT from the SYSTEM disk. HDMAINT is an extremely easy program to use, relying exclusively on function keys and detailed menu screens to guide the user through any operation.

HDMAINT is used to create the CCP/M-86 partition; it will also define the options in effect during

**W**ith some work, a PC-XT can support MS-DOS and CCP/M-86 simultaneously, providing maximum flexibility for the user.

CCP/M-86 operation—options such as time stamping and read-verify after disk-write operations.

At the completion of this process, perform a DSKRESET (which permits write operations to the hard disk) and transfer the program CCPM.SYS to the hard disk. At this point, CCP/M-86 is *capable* of being booted on a power-on.

## WHICH OPERATING SYSTEM WILL BOOT?

The final piece to this puzzle is determining which operating system should be booted on a power-on. The system can be set to boot any partition desired; once set, no other partition can be booted unless the bootable partition is changed. Both FDISK and HDMAINT provide the ability to change the bootable partition to themselves or to any other bootable partition. Each program knows the whereabouts of other partitions by examining the partition data on the hard disk, but it doesn't know the identity of its cohabitants.

Be careful when using the program HDMAINT to change the bootable partition. The status message that identifies the current bootable partition is not always correct when within HDMAINT; I have found the only sure way to change the partition is to leave HDMAINT and re-enter to verify the partition change. The procedure is still relatively simple; just go slowly and read the documentation carefully.

## IS THERE A PLACE FOR CCP/M-86 ON MY PC?

There is a lot to absorb when trying to learn CCP/M-86. It is an operating system that is worthy of the IBM PC—one that supports full multi-tasking, a feature that will be used by more software in the future. Evidence of this is already being seen, as companies such as VisiCorp, Microsoft, and IBM introduce windowing software that will enhance the features of CCP/M-86 on the PC.

**C**CP/M-86's biggest limitation is its lack of a hierarchical directory. Also, since the operating system requires 256K and the price is much heftier than that of MS-DOS's, I imagine that few "small guys" will be using it now.

CCP/M-86 has its drawbacks, as does any software. Its biggest limitation is its lack of a hierarchical directory. Also, since the operating system requires 256K and the price is much heftier than MS-DOS's, I imagine that very few "small guys" will be using it at this time.

CCP/M-86 is a rich system. From a technical standpoint, it can be judged as stiff competition for MS-DOS. If you are looking for advice from me as to which one to use for your new PC, however, I can ask only one question: which system does your software need?

Don Awalt is Vice President for Development at Muse Software. He is a former assistant professor who taught Theory of Operating Systems at Loyola College.

## A Note on Performance

Two conclusions can be reached based on the results of some basic benchmark tests to measure the performance of CCP/M-86: First, concurrent execution of several tasks with CCP/M-86 can produce a substantial time savings for the user, when compared to a single-tasking alternative. Second, CCP/M-86 is slower than MS-DOS.

Several different tests were conducted in an attempt to derive these conclusions about performance. Three tests in particular proved the efficiency of multi-tasking CCP/M-86 and also demonstrated the single-tasking speed advantage of MS-DOS.

First, a file 60K bytes long was transferred from one hard-disk file to another. Second, that file was transferred from a hard disk to a diskette drive. Finally, a double-sided diskette was formatted.

Transferring a file from hard disk to diskette drive under CCP/M-86 took 20 seconds when no other tasks were running and took 48 seconds when three other tasks were "concurrently" executing (the other tasks were TYPE-ing a large ASCII file to their respective virtual consoles). If each of the four tasks had received 25 percent of the computer's resources to execute, the execution of the file transfer with single-tasking efficiency would have taken 80 seconds. The time that actually elapsed—which was 48 seconds—showed an increase in performance of 40 percent.

Transferring a hard-disk file to another hard-disk file took 9 seconds in single-user mode and 24 seconds when three other tasks were running. These results represent an improvement of 33 percent for concurrent operations over single-tasking.

Tests comparing CCP/M-86 and MS-DOS when both were in a single-task environment were then run. CCP/M-86 fared poorly in this comparison, with all tests producing comparable results.

A file transfer from hard disk to diskette drive took 10 seconds under MS-DOS, yet took 20 seconds under CCP/M-86. In this example, MS-DOS was exactly 50 percent faster.

A transfer from one hard disk to another under MS-DOS took 4 seconds, compared with 9 seconds for CCP/M-86 in single-user mode. MS-DOS was 55 percent faster in this operation.

The final comparison, the formatting of a double-sided diskette (with verify), produced similar results. MS-DOS could format a disk in 41 seconds, while CCP/M-86 took 69 seconds. MS-DOS thus had a 41-percent advantage over CCP/M-86.

What do these numbers mean? CCP/M-86 undoubtedly has a tremendous amount of additional software to support its concurrent operations; this software produces performance overhead even when only one task is executing. It is interesting to note that CCP/M-86 fared the best in the diskette-formatting test, because virtual-console switching (and possibly some overhead) is prohibited during use of the format program.

The conclusion is simple: the potential to perform concurrent operations has a price, but if multi-tasking can be used, the resulting benefits over single-tasking within CCP/M-86 are immense.

# Defining Function Keys Using ANSI.SYS

*A program to assign new definitions to function keys*

TECH  
NOTEBOOK  
14

ARTHUR A. GLECKLER

DOS 2.0 provides installable device drivers, which allow standard control of input/output devices. Using device drivers, the programmer can achieve device independence, which allows the user to ignore the details of operating a device.

Included with DOS 2.0 is a keyboard driver: ANSI.SYS (described in Chapter 13 of the DOS manual). ANSI.SYS provides the user extended

cursor and screen control, as well as the ability to redefine the function of any key.

The extended functions are accessed through escape sequences that are sent to the ANSI device driver. For example,

**ESC [2J**

is the escape sequence to clear the

screen and home the cursor (ESC is character code 27).

The program listed below, written in IBM Pascal, makes use of the ANSI.SYS key redefinition function. Using this program, a function key can be assigned a new definition, such as "dir." Unfortunately, ANSI.SYS keyboard redefinitions do not hold under IBM BASIC. ■■■■■

## LISTING 1: PROGRAM USING THE ANSI.SYS KEY REDEFINITION FUNCTION

```
{ Program to Set Up Function Keys Using
  ANSI.SYS Keyboard Driver Under DOS 2.0
Version 840110.1 Pascal IBM PC
Latest 840111
Arthur A. Gleckler
```

Before this program is used, the ANSI.SYS keyboard device driver should be installed. This is done by placing the line

device=ansi.sys

in a file called CONFIG.SYS on the disk which the computer is booted from. A copy of the ANSI.SYS program should also be present on the boot disk.

}

PROGRAM FnKeys;

TYPE

DefString = STRING [20];

PROCEDURE ID;

{ Identify program to user }

BEGIN

```
  WRITE (CHR (27), '[2J');
  { Clear the screen and home cursor }
  WRITE ('Program to Set Up Function Keys');
  WRITE (' Using ANSI.SYS Keyboard Driver');
  WRITELN (' Under DOS 2.0');
  WRITELN;
  WRITE (' The ANSI.SYS keyboard driver');
  WRITE (' must be installed before this');
  WRITELN (' program is run.');
  WRITELN
```

END;

```
PROCEDURE DefineKey (FunctionKey:INTEGER;
                      NewString:DefString);
{ Sends codes to ANSI.SYS keyboard driver
  to redefine a function key; function keys
```

```
have extended ASCII codes, with a 0
followed by a number 59-68 for function
keys 1-10, respectively
}
```

```
BEGIN
  WRITE (CHR (27), '[0;');
  WRITE ((FunctionKey + 58):2, ';');
  WRITE (NewString, '";13p')
```

END;

```
PROCEDURE SetupKeys;
{ Ask user which key to redefine and what
  new definition is
}
```

```
VAR Number : INTEGER;
  Definition : STRING [20];
BEGIN
```

REPEAT

```
  WRITE ('Please enter the number');
  WRITE (' (1 - 10) of a function');
  WRITELN (' key to redefine');
  WRITE (' or enter 0 if all key');
  WRITELN (' redefinition is complete.');
  WRITE ('Function Key Number: ');
  READLN (Number);
  IF Number IN [1..10]
```

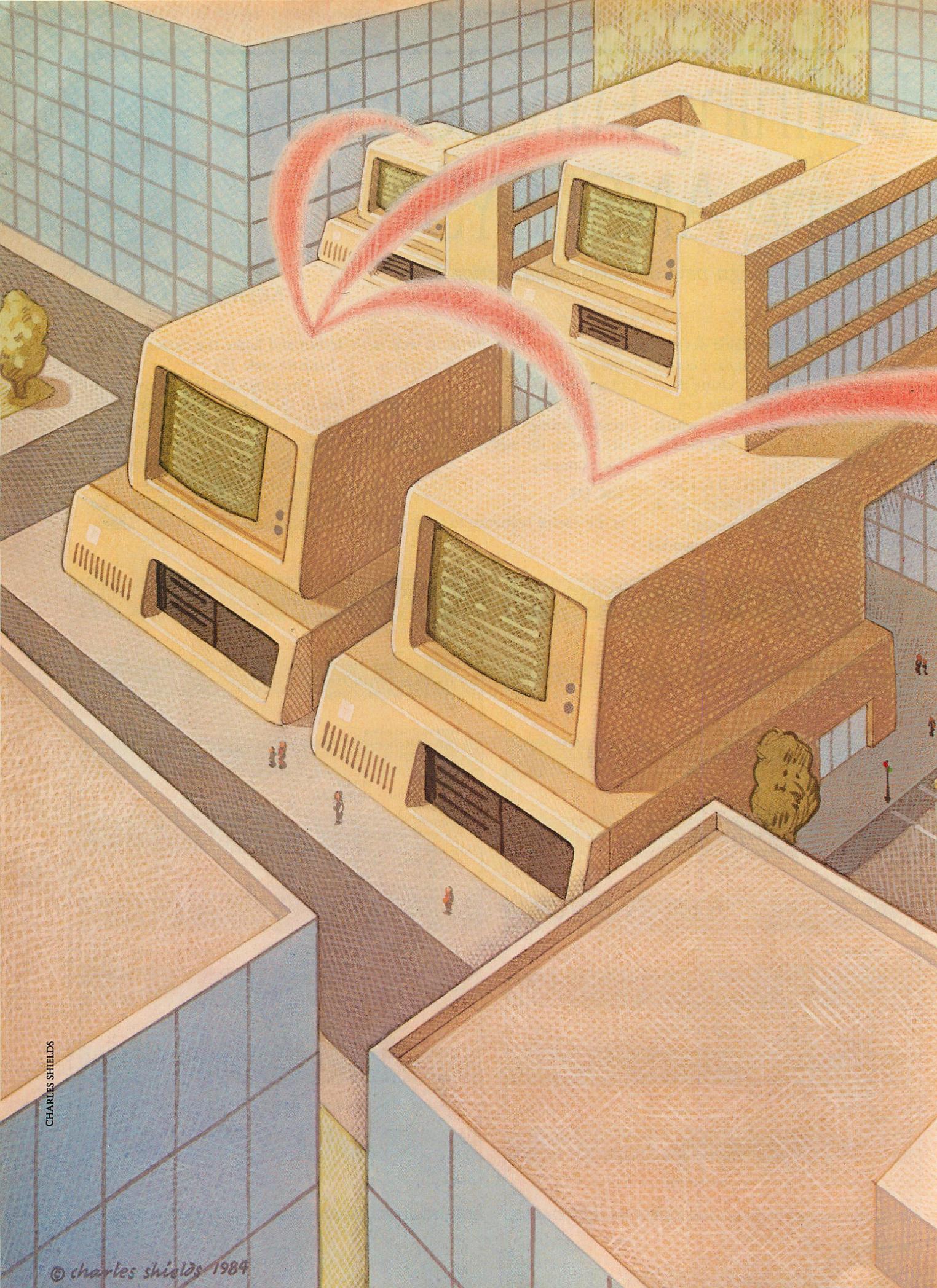
THEN

```
  BEGIN
    WRITE ('Enter definition');
    WRITELN (' for F', Number:1, '.');
    WRITE ('Definition String: ');
    READLN (Definition);
    DefineKey (Number, Definition);
    WRITE ('F', Number:1, ' = ');
    WRITELN (Definition);
    WRITELN
```

END

```
UNTIL NOT (Number IN [1..10]);
WRITELN;
  WRITELN ('Function key setup ended.')
END;
```

```
BEGIN
  ID;
  SetupKeys
END.
```



CHARLES SHIELDS

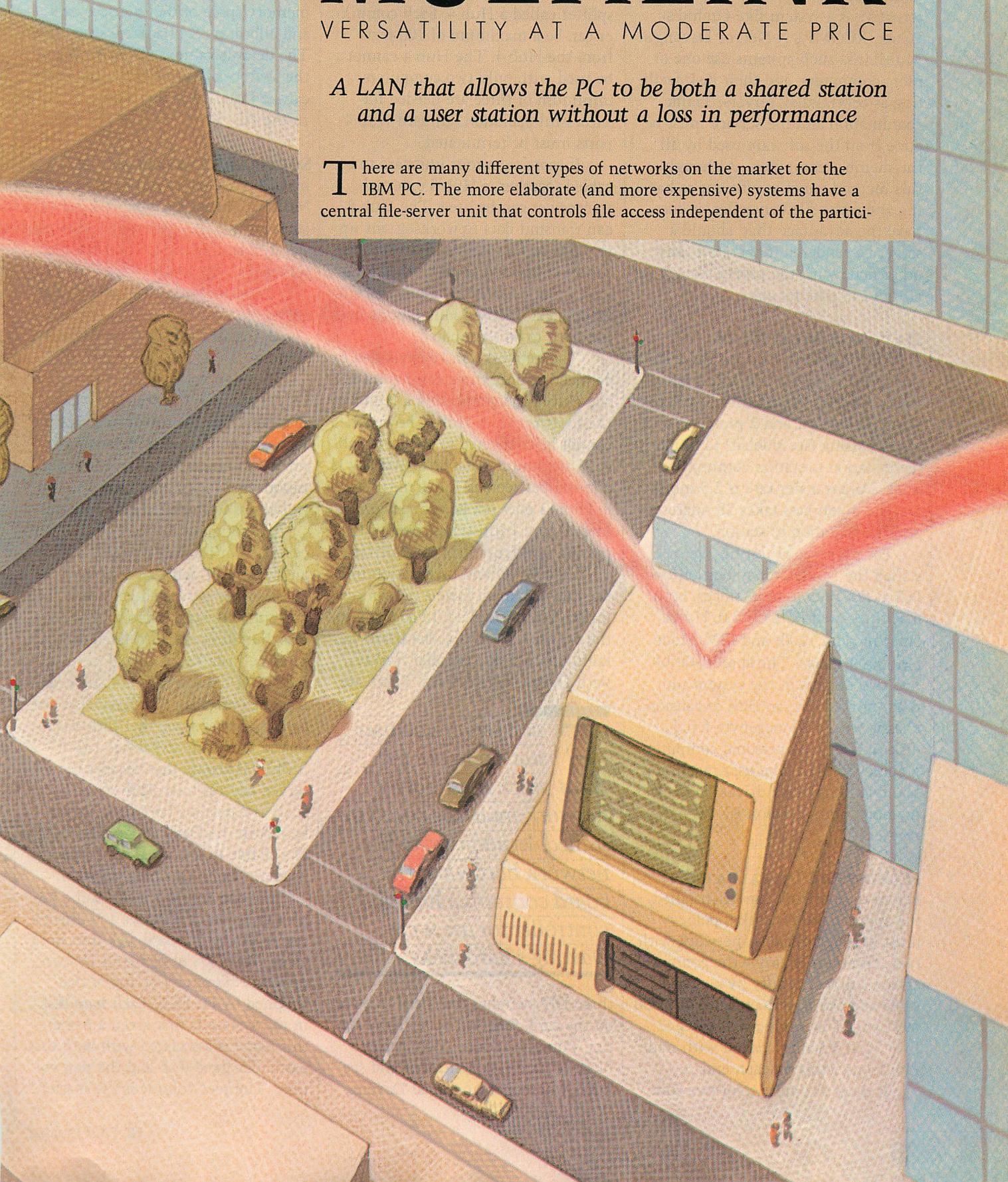
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# DAVONG'S **MULTILINK:**

VERSATILITY AT A MODERATE PRICE

*A LAN that allows the PC to be both a shared station and a user station without a loss in performance*

There are many different types of networks on the market for the IBM PC. The more elaborate (and more expensive) systems have a central file-server unit that controls file access independent of the partici-



# MULTILINK

SUSAN GLINERT-COLE

pating computers. A less-expensive alternative is a system like Orchid's PCnet, XCOMP's X-Net, or Davong's MultiLink; such systems use one or more computers, and their disk facilities, as central disk servers. Traffic coordination and file service must be done from the software used by all the member computers. Although this method is not as efficient as having a separate file controller, it does have the advantage that, should a server be rendered inoperative, any other node with the proper storage facilities can take its place.

## DAVONG'S MULTILINK

A MultiLink starter kit for three stations, including all cables and software, is \$2395. MultiLink uses Xerox Standard levels 1 and 2 protocols and token passing (see sidebar) to implement station-to-station communications. Data-transfer rate is 2.5 mbit/sec; the token pass takes 28 microseconds from station to station.

For purposes of testing, we installed the MultiLink system on two PCs at *PC Tech Journal* offices; both machines used PC-DOS 2.0, Hayes Smartmodem 1200s and IBM Monochrome displays. The sharer station had two floppies in the system unit, 320K of memory, an IBM expansion chassis with a 10-megabyte fixed disk, and an IBM personal computer graphics printer. The user machine had two floppy disk drives, 512K of memory, and an Epson RX-80 printer.

## HARDWARE INSTALLATION

Before the network can be installed, the appropriate network topology must be determined. A network with two computers is easy—the computers are connected only by a coaxial cable and can be a maximum of 2,000 feet apart. The cable used is RG-62, IBM 3270, 93-ohm coaxial with male BNC connectors on each end.

If there are more than two com-

puters, a multiple connect unit, called a hub, must be used. For three or four computers, the units can be interconnected via a passive resistor splitter called a Hub 4. Each computer can be a maximum of 100 feet from the Hub 4. The Hub 4 cannot be used with only two computers; a minimum of three are needed for successful operation. Unused Hub 4 ports must be terminated.

If more than four units are to be cabled together, a Hub 8 external transceiver can be used. The Hub 8 can transmit data to workstations up to 2,000 feet away. Multiple Hub 8s can be connected to each other for a maximum linear network distance of 20,000 feet. Unused Hub 8 ports do not need to be terminated.

The network can be expanded by connecting only three computers to the Hub 4 and connecting a Hub 8 to the fourth port. A Hub 4, however, cannot be connected to another Hub 4. A maximum distance of 100 feet is allowed between a Hub 4 and a Hub 8. Hub 8s may not be connected in a loop. Figure 1 illustrates some of the possible configurations of MultiLink.

Each server and user station in the network must have a network-interface board installed. In addition to the network hardware, the board contains a hard-disk controller for use with Davong's hard disks. There are

***E*ach server and user station in the network must have a network-interface board installed. In addition to the network hardware, the board contains a hard-disk controller for use with Davong's hard disks.**

three DIP switches that need to be set on the card. Switch 1 reflects the station's unique address. Switch 2 enables the hard-disk controller and specifies whether the optional Davong

boot PROM (which allows PCs with the older 64K system boards to boot directly from the fixed disk) is being used. Switch 3 sets the base-address memory space of the interface card and allocates 8K of address space to it. The default value is CA000h. When the switches have been set, the board can be installed in any slot in the PC.

## SOFTWARE INSTALLATION

Installing Davong's software, called Multi-OS, is not a simple task. The steps are

1. install Multi-OS on each file server
2. install MultiLink on each file server
3. install MultiLink on the workstations

4. assign volumes on each station.

In addition to executing local programs, the file server manages the local shared hard disk, providing pipes for station-to-station communications and locks/semaphores to control access to the fixed disk volumes.

The original software we received from Davong would not allow an XT or a PC with an expansion chassis to be part of the network. The current software version will allow this, but all of the IBM fixed disks must be installed as shared units; a local IBM fixed disk is not allowed. Davong currently uses fixed-disk controller address space that IBM has reserved for future expansion (324h-32Fh). Hardware that decodes the reserved address lines 320h to 32Fh, such as Apparat's hard disk, cannot be run in the Davong network, either as a shared or as a local disk. Davong promises to fix this problem soon.

Davong employs a confusing implementation of volumes and directories to divide the hard disk into work areas. Multi-OS implements its own directory hierarchy on top of that supplied by PC-DOS. Each hard disk in the system is first given a name; this name is associated with both that particular fixed disk and the root volume. The root volume is the master

disk directory through which all other disk directories and volumes are referenced. Up to 16 characters are allowed, and spaces can be included in the root volume name. No two shared disks in the system can have the same root volume name.

The root volume can in turn be divided into Multi-OS directories. Such directories, unlike those of DOS 2.0, do not themselves contain files; they hold either subdirectories or volumes. These volumes, not to be confused with the root volume, can contain files. The user can access these files by assigning the volume to a virtual-drive letter. Once a volume has been associated with a drive letter, the PC-DOS 2.0 file and directory commands can be used as usual.

The distinctions among a device, a volume, a directory, and a drive are not well explained in the manual; the prompts within the Davong software sometimes refer to the shared drive in question as /1 or /ROOT (or whatever name has been given to the volume). Directories are defined as a type of volume, but volumes can contain files and directories cannot. This distinction becomes clearer with the knowledge that Davong defines several different types of volumes:

1. A directory is a volume that contains the names of the data volumes under its purview—it is an index to other volumes.
2. A data volume contains text, data, or program files.
3. A pipe volume is used to send and receive information between two workstations. It is a first-in, first-out queue managed by the file server. One workstation can write data into the pipe while the other station reads data from it. Data written to a pipe is appended to information already present. A pipe read returns, and then removes, data from the head of the pipe. Data written to a pipe remains available until it is read (or the pipe is erased). Application programs from differ-

ent workstations using the pipe therefore need not run at the same time.

4. An import/export volume is a temporary volume used to move files from one volume to another.

Figures 2 and 3 illustrate the file-hierarchy structure for PC-DOS 2.0

**T**he root volume can in turn be divided into Multi-OS directories. Such directories, unlike those of DOS 2.0, do not themselves contain files; they hold either subdirectories or volumes.

and Multi-OS. Access to file GRUE in the Multi-OS schema is gained by assigning the volume BIG to a virtual drive; as in DOS, BIG is completely referenced through a directory hierarchy. In this case, the hierarchy is /ROOT/ANIMAL/HOSTILE. Once /ROOT/ANIMAL/HOSTILE/BIG has been assigned to a drive letter, the volume is treated as a virtual drive, and all manipulations, such as creating directories and accessing files, can be accomplished as they usually are with DOS 2.0.

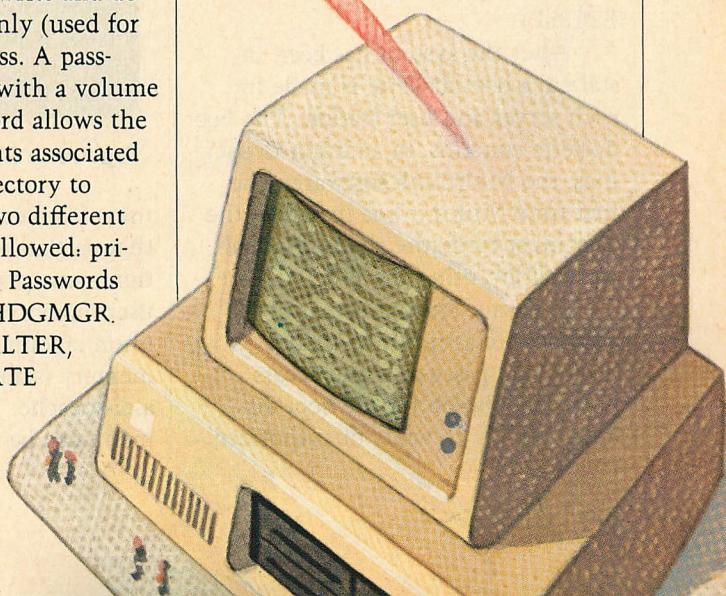
Passwords and access rights can be assigned both to directories and to volumes within directories. There are four access rights available: read/write (person can read/write and delete); read only; write only (used for mailboxes); and no access. A password can be associated with a volume or directory; the password allows the user to exercise the rights associated with the volume or directory to which it is assigned. Two different types of passwords are allowed: private (owner) and group. Passwords can be assigned by the HDGMGR program with the ALTER, EXPORT, and CREATE options. Alternatively, the name/password

option can be specified in the Boot Options menu.

To list volumes in a directory, a person must have read access to that directory. Similarly, write access is required to create a volume in that directory. Deleting a volume requires a user to have write access to both the volume and the directory (or drive) containing the volume. Access rights to a volume can be altered only by a user who knows the password.

The INSTMOS program is used to format a hard disk for initial installation of Multi-OS, to set up default volume assignments, to format a slave disk, or to add an additional operating system (CPM/86 and UCSD p-System are currently supported). The hard disk can be divided into as many volumes as desired, and the size of the volume can be as large as the total available disk space. INSTMOS presents a set of generic volumes; if none of these are suitable, the program HDMGR (hard disk manager) can be used to create another configuration.

Volumes generated through INSTMOS or HDMGR are like drives in that they can be assigned to drive letters (Davong calls this mounting a volume). Up to six volumes can be mounted by a user at any one time (assigned to drive letters A: through F:). Floppies are also treated as volumes, so the common method is to assign drive A to floppy 1 (F1), drive B to floppy 2, and the root volume to drive C. The remaining letters can then be assigned to



# MULTILINK

user-defined volumes, such as SALES or ACCOUNTING. Figure 4 shows a sample volume assignment created with the program HDMGR.

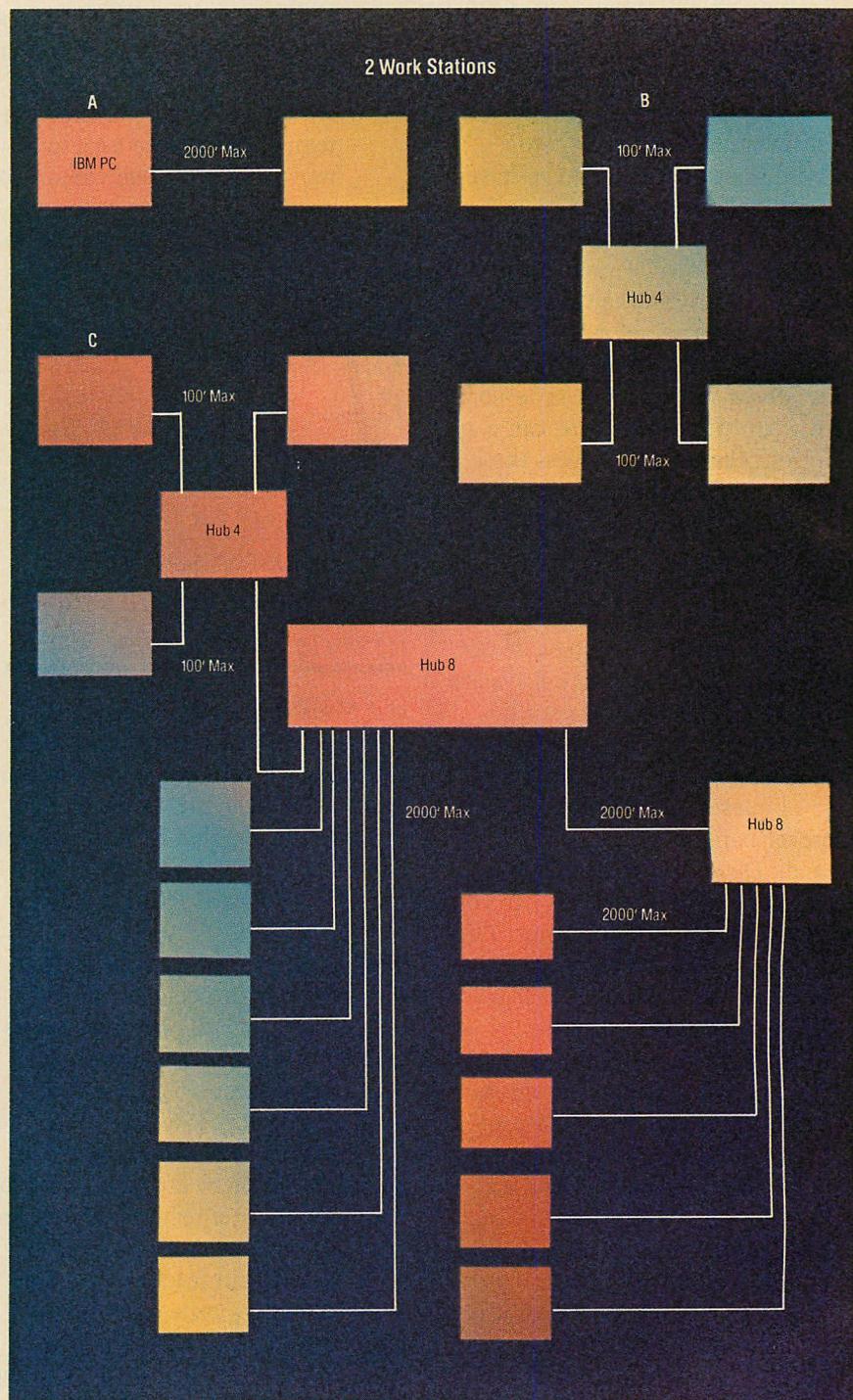
HDMGR presents a series of choices for managing the hard disk. Among other options, a user can create, delete, list, or alter the attributes of a volume. Each command presents a menu screen, and the user's choices are entered in the appropriate areas. Suppose the name of the hard disk is ROOT. To create a volume, choose the CREATE option on the menu and enter the name and size of the volume in IBM path syntax (/ROOT/ROOTYTOOT).

A directory can be created in two ways: with the standard IBM MKDIR command or implicitly when creating a volume with HDMGR. For example, suppose we want to create a directory of volumes under ROOT. We again choose the CREATE option, but this time type /ROOT/VEGETABLE/INEDIBLE in response to the name prompt. VEGETABLE

**M**ulti-OS must be installed on every hard disk in the network; thus all the fixed disks can be shared.

will be a directory within ROOT that contains the volume INEDIBLE in its table of contents. Other volumes can be created under VEGETABLE with the same procedure (e.g., /ROOT/VEGETABLE/EDIBLE creates volume EDIBLE).

After the system has been installed, a boot diskette is made for each server and user station. The boot diskette contains, in addition to user files, the MultiLink software. The first time MultiLink is installed, the user must configure the individual workstation using the BOOT OPTION menu. From this menu, the volumes are assigned to virtual drives, and passwords and access rights are chosen for the boot diskette, which prevents unauthorized

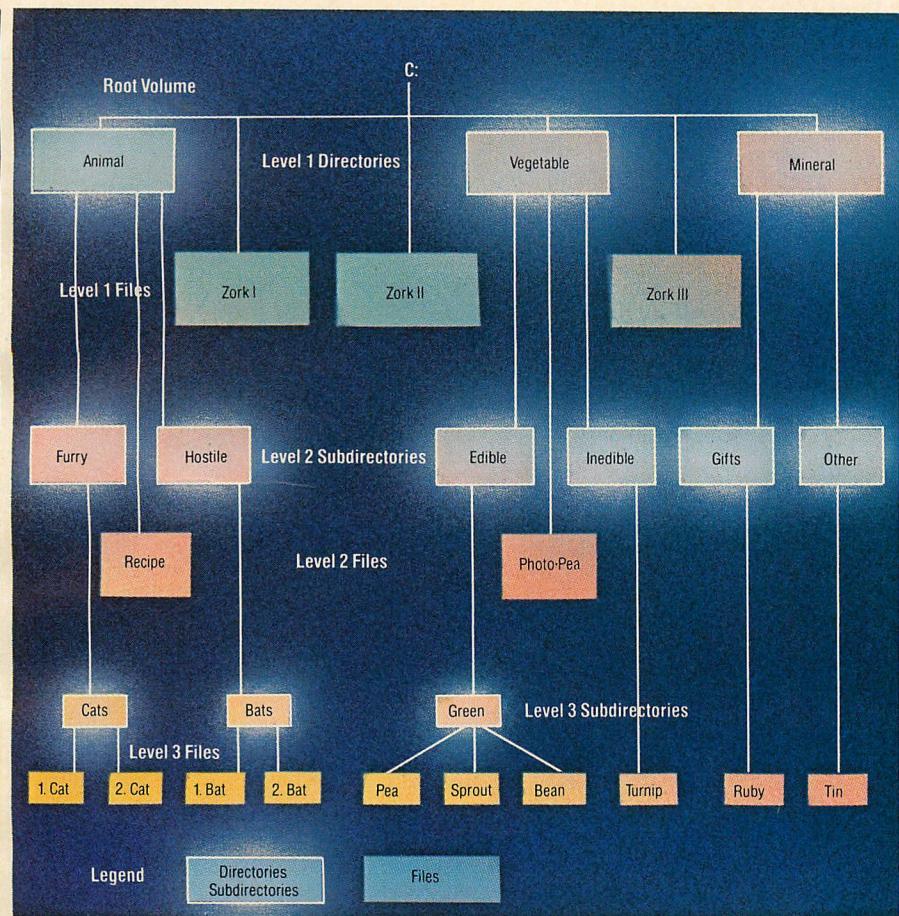


**Figure 1: MultiLink Network Topology**

users from entering the network with that particular boot diskette. The option menu also allows the amount of user memory to be selected (minimum amount is 109K). Unused memory is automatically allocated to a disk cache. The BOOT OPTION menu can be accessed each time Multi-

Link is booted, allowing the user to reconfigure the boot parameters as often as may be desired.

Default volume assignments can be made in the Boot Option menu at the time of installation. If a user wishes to access a volume after connecting to the network, the MOUNT



**Figure 2: DOS 2.0 Directory Structure**

utility can be used.

Multi-OS must be installed on every hard disk in the network; thus all the fixed disks are potentially shareable. A user may isolate the hard disk from other stations by creating the disk volume with a "private" attribute and password. Once Multi-OS is installed on the fixed disk, however, a user can access the disk only under the Multi-OS operating system. If the computer is booted under MS-DOS, the fixed disk is inaccessible. If the user wants to reinstall MS-DOS on the fixed disk, the disk must be erased and reformatted.

The ability to keep a shared fixed disk from becoming corrupted in a multi-user environment is one of the most important factors to be considered when choosing a network. Without some form of multiple-write protection, files and directory information may not reflect the true state

of the volume. For example, if two stations create a file with the same name at the same time, the directory will contain the name of only one of them; the other will be lost. Another problem arises when two stations simultaneously extend a file. The same disk space may be allocated by the file-allocation table, and the two files will be cross-linked.

Davong provides a program called SHRDOS that allows multiple stations using PC-DOS to safely share data volumes. SHRDOS can keep track of 32 open files on the fixed disk. Users can create, delete, append, read, and write files on the shared fixed disk without corrupting the disk directory or file-allocation table.

In order for this sharing method to be effective, all stations in the network must have installed SHRDOS; this is done most conveniently in the AUTOEXEC.BAT file. Anyone in

the network not using SHRDOS can cause volume corruption while modifying a shared volume. SHRDOS automatically locks a file being written to and unlocks it when the write has been completed. If a file is in use when a write request is made, SHRDOS sends the user a LOCK IN USE message. The program will continue to try until the file becomes available or until the user tells it to abort the request or to ignore the lock. Ignoring the lock is equivalent to not using SHRDOS at all.

Extended function calls are used to implement the locking procedures. The normal INT 21h vector is replaced with a jump to a different address containing the SHRDOS logic. INT 21h is moved to INT 64h. These extended calls are available for integration into application programs. SHRDOS uses about 12K of resident RAM in each machine.

SHRDOS has two methods of sharing volume files. The first is a shared read-only mode, in which several users can simultaneously read a file, but only one may write to it. The second is a private mode, in which only one user at a time may access a given file. In addition, the RESERVE utility will reserve an entire volume for exclusive use by a single user. All network users must have previously installed SHRDOS for RESERVE to function correctly.

SHRDOS can be installed with several optional parameters:

/R: allows multiple read.

The first user to write to the file prevents any other writes until he or she is finished.

/W: only one user at a time will be allowed to access any file (same as no options)

/N: no file locks. Locks are still used to protect disk information and the file-allocation table, but any number of users may have the same file open for read/write/delete/

# MULTILINK

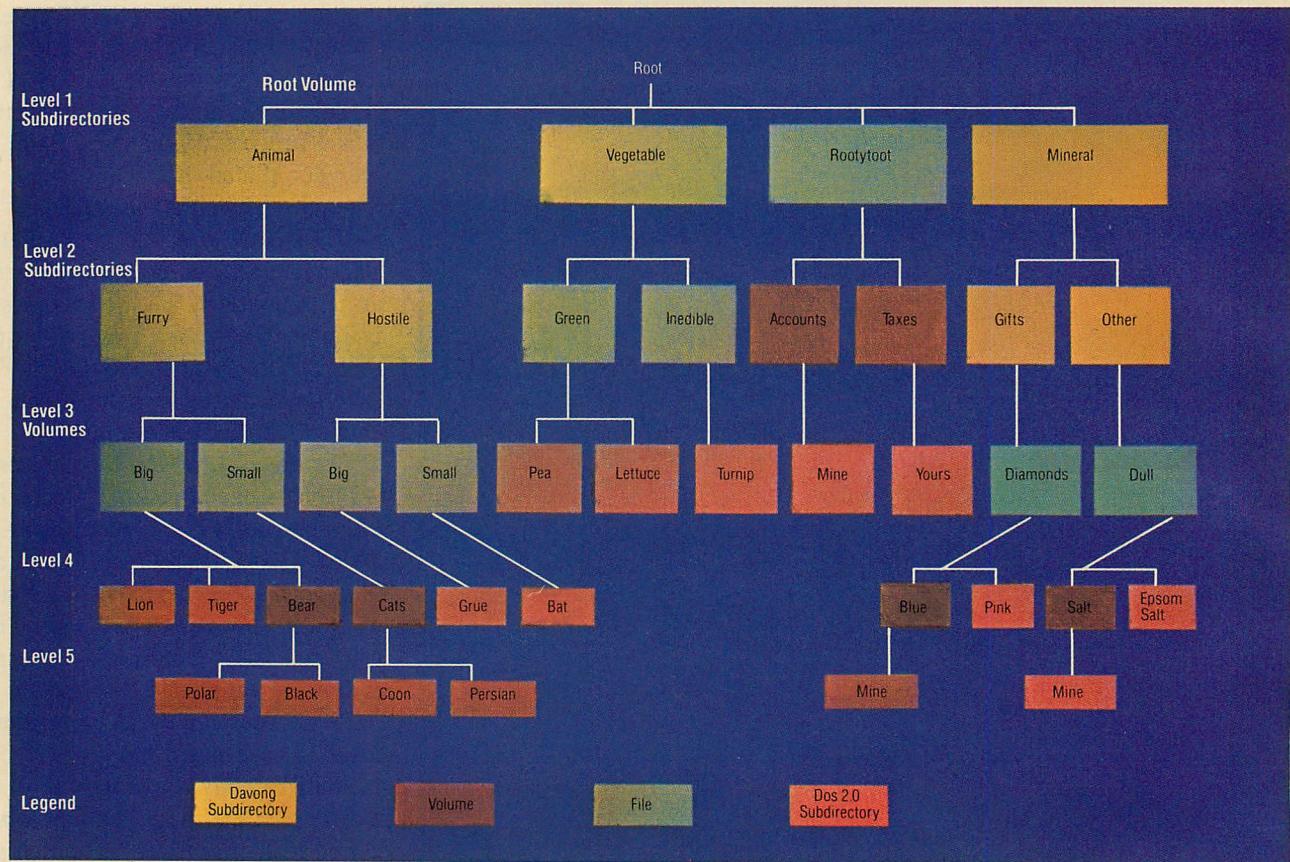


Figure 3: Multi-OS Directory Structure

create/append. Two users extending a file simultaneously will lose disk allocation blocks and one of the extends will be lost.

Davong supplies a print spooler that can support up to two parallel or

**T**he PRINT program replaces the PC-DOS 2.0 print utility and is just as simple to run. The MultiLink command PRINT will list all queued files at that station, with the station's default printer at the top of the list.

serial printers per networked PC, up to a total of 64 printers per network. The spooler software consists of four

programs: PRINT, a high-level interface; SPOOLMGR, a setup and control program that installs and manages print queues; PRNSAVE, a routine that redirects program output from the standard print device to a file; and SPOOL, which arbitrates the printing of spooled output.

The PRINT program replaces the PC-DOS 2.0 print utility and is just as simple to run. The MultiLink command PRINT will list all queued files at that station, with the station's default printer at the top of the list. If the PRINT command is followed by a list of filenames, all the files will be output to the default printer.

PRINT can be followed with an optional switch for expanding tabs to blanks. This is extremely useful, especially if a program editor does not do this automatically and the printer does not have default tab settings. If the print queues are full, the program issues a warning and retries every ten seconds until the file has been suc-

## DRIVE VOLUME

A:	:F1
B:	:F2
C:	/ROOT/ANIMAL/FURRY/BIG
D:	/ROOT/VEGETABLE/INEDIBLE
E:/ROOT/ROOTYTOOT	
F:	/ROOT/MINERAL/GIFTS/DIAMONDS

Figure 4: Drive and Volume Assignments in Multi-OS

cessfully queued or the user exits PRINT via a Ctrl-Break. Files may be deleted from the queue easily by following the command PRINT <filename> with a /C.

The SPOOLMGR program is used to set the defaults for PRINTER. The user can opt to print a banner page in order to separate multiuser output at the shared device; set the default printer and printer param-

**Table 1: Benchmark Performance of MultiLink with IBM Fixed Disk**

PC-DOS 2.0	1 user user stn.	1 user shared stn.	2 users user stn.	2 users shared stn.
<b>I/O BENCHMARKS (in seconds)</b>				
random access	6	7	4	9
sequential read/write	29	28	24	44
sequential read	14	15	13	15
dBASE sort, 1 key	40	43	38	42
dBASE Index, 1 key	29	31	20	31
dBASE Index, 2 keys	29	31	20	27
<b>WORD PROCESSOR BENCHMARKS</b>				
Word Perfect (Ver. 2.3):				
load wp from hard disk	4	8	4	9
load wp from floppy disk	14	12	13	13
exit wp (to hard disk)	1	3	2	3
load file from floppy	4	4	5	4
save file to floppy	18	18	23	20
load from hard disk	2	3	3	4
save file to hard disk	15	17	16	17
WordStar (Ver. 2.3):				
load wp from hard disk	6	6	5	7
load wp from floppy disk	7	8	9	8
exit wp (to hard disk)	0	0	0	0
load file from floppy	3	5	4	5
save file to floppy	32	31	33	32
load file from hard disk	3	4	3	4
save file to hard disk	10	11	11	12
				15

ters; delete the print queue, and interrupt print service. SPLMGR must be run at least once before network print spooling can proceed.

#### DOCUMENTATION

Davong supplies extensive literature with MultiLink: more than a dozen stapled pamphlets, inserts, addenda, and notes. There is a lot of information here, but the manuals are disorganized and confusing in places, and it is difficult to locate relevant data on a particular subject. The instructions for installing the system are lucid in places, but other sections are scanty or omit vital information. For example, there are several pages devoted to removing the cover of the system unit, but it is unclear whether MultiOS need only be installed on a server unit or whether it must be present on all the hard disks in the

network, and there simply aren't any instructions in any of the manuals for installing user workstations.

Because Davong does not sell directly to the end user, the documentation assumes that the people installing the network have been trained to set it up and to instruct the end-user in its use. However, Davong plans to reissue the documentation in standard IBM binders, completely reorganized and updated.

Davong supplies plenty of technical information, including a complete list of function calls for MultiLink and the printer spooler. By presenting an open system, Davong is encouraging software developers to create application programs that can take advantage of the network environment.

Network-interface modules for semaphoring, piping, and setting passwords are included with MultiLink.

Davong has provided both the source and the object code for these subroutines in several different formats: in assembly language and as object files for use with the IBM Pascal compiler and Computer Innovations C86 compiler. In addition, a special set of routines is supplied for use with BASIC running under DOS 2.0; these routines allow locking and unlocking of BASIC records to control access to shared random-data files. Sample BASIC programs using these routines are included in the documentation.

#### PERFORMANCE

It is important to bear in mind that PC-DOS was never meant to support more than one user. A multi-user

**T**here is a lot of information in MultiLink's documentation, but the manuals are disorganized and confusing in places, and it is difficult to locate relevant data on a particular subject.

network built on such an inappropriate foundation can be expected to exhibit some performance degradation, especially if file service is controlled from a network node and not through a separate disk server. The extent to which network users interfere with one another will depend on a combination of factors. The density of network traffic, as well as the functions the network is asked to provide, will have an impact on the speed with which individual tasks are completed. With a two-PC network, MultiLink had little effect on performance; in fact, it outperformed PC-DOS 2.0 on several of the benchmark tests when only one user was on the network.

We wrote six small benchmark programs to test the performance of these two networks with a heavy I/O load (see table 1). The random-access

# MULTILINK

**Table 2: Benchmark Performance of MultiLink with Davong Hard Disk**

	PC-DOS 2.0	1 user user stn.	1 user shared stn.	2 users user stn.	2 users shared stn.
<b>I/O BENCHMARKS</b>					
random access	6	—	7	17	17
sequential read/write	29	—	23	43	41
sequential read	14	—	13	15	16
dBASE sort, 1 key	40	—	39	43	43
dBASE Index, 1 key	29	—	27	30	30
dBASE Index, 2 keys	29	—	29	30	27
<b>WORD PROCESSOR BENCHMARKS</b>					
Word Perfect (Ver. 2.3):					
load wp from hard disk	4	—	4	10	6
load wp from floppy disk	14	—	10	17	17
exit wp (to hard disk)	1	—	1	3	2
load file floppy	4	—	4	4	4
save file to floppy	18	—	19	19	15
load file from hard disk	2	—	2	5	3
save file to hard disk	15	—	4	17	16
WordStar (Ver. 2.3):					
load wp from hard disk	6	—	6	7	7
load wp from floppy disk	7	—	7	8	7
exit wp (to hard disk)	—	—	instant	—	—
load file from floppy	3	—	3	4	3
save file to floppy	32	—	33	33	32
load file from hard disk	3	—	3	4	4
save file to hard disk	10	—	9	20	22

test writes 50 records, within a thousand-record file, to 50 other records. Each record is 50 bytes long. The sequential-read test reads 641 lines, each 50 bytes long within a 40,000-byte file. The sequential read/write test first reads and then writes 641 50-byte lines to another file.

The programs were run under several different conditions, with the MultiLink hardware always *in situ*, except for the control tests in the standard single-user PC-DOS environment. The single-user tests were done on each unit while the second computer stood idle. Next, the tests were performed with both computers simultaneously running the benchmarks from different volumes on the shared hard drive.

Under PC-DOS alone, the random-access test took 6 seconds, and

**D**avong's MultiLink is a powerful, friendly, and high-performance network at a reasonable price. The few benchmarks we ran here indicate that there is little performance degradation with two users, although performance might be expected to decline with a higher station load.

the read test took 14 seconds. MultiLink's time for these benchmarks did not differ significantly from the control. The single-user dBASE II bench-

marks showed comparable effects from the network software. Again, MultiLink's time differed by a second or two at most from PC-DOS 2.0.

We also speed-tested simultaneous program execution. Both users ran the programs from different volumes on the shared hard disk. MultiLink's performance degraded slightly in the sequential read/write test, but was otherwise still comparable to PC-DOS 2.0. We benchmarked the performance of two word processors in the same way. The results indicate again that MultiLink adjusts very well to multiple disk access requests.

Because Davong has been marketing external fixed disks for the IBM PC for a long time, we also set up MultiLink on a Davong 5-mega-byte drive and ran the set of benchmarks. The results, presented in table 2, show MultiLink has a generally better performance on the IBM fixed disk than on the Davong. These numbers may be misleading, because the IBM fixed disk has cylinders twice the size of those on the Davong fixed disk we tested, which could enhance disk-access time.

## CONCLUSIONS

Davong's MultiLink is a powerful, friendly, and high-performance network at a reasonable price. Although installation requires more planning than a simple straight-line bus configuration and the implementation of the volume concept takes some getting used to, once installed, MultiLink is transparent to the end-user. The few benchmarks that we ran here indicate little performance degradation with two users, although performance might be expected to decline with a high station load.

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## TOKEN-PASSING PROTOCOLS

When computers are tied into a network, some method of traffic control must be established to effectively share the available resources. A common time-sharing protocol for ring networks is called token passing. The token itself is a special bit pattern that constantly circles the network, indicating to all nodes that the channel is clear. To send a message, the station must put the message in proper form, grab the token, and transmit the data.

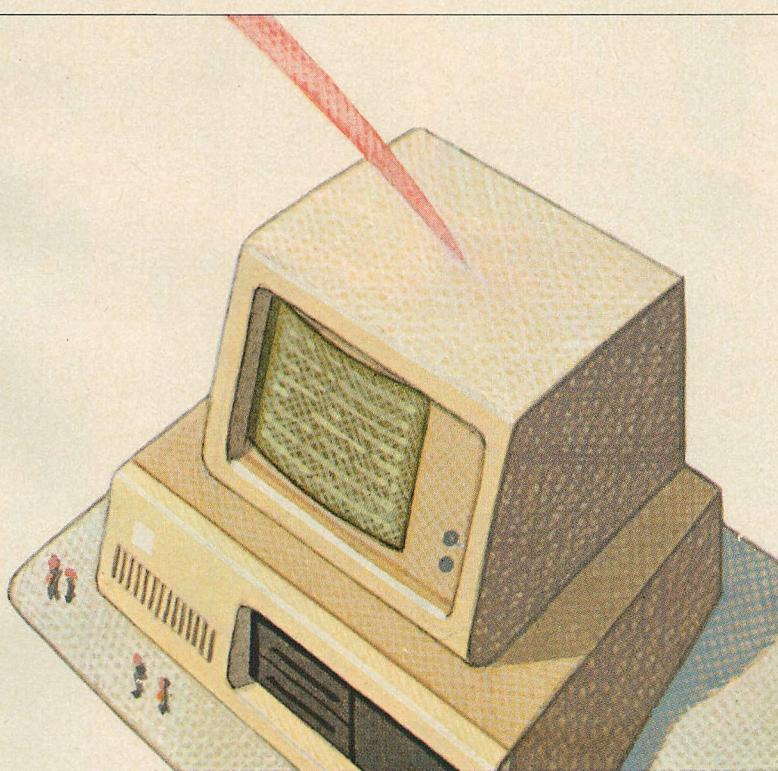
As in CSMA/CD protocols, the message to be sent must first be divided into packets consisting of a header, a data field, and a trailer. The packets are stored in a send buffer, and the station waits until the token has been passed to it before placing the packet on the network channel. The sender then checks to see if the receiver can receive the message. If so, the message is transmitted and an acknowledgment is returned by the recipient. If the destination did not receive the message correctly, the sender resends it. If the intended recipient is not active, the sender will recognize this, as no acknowledgment is returned.

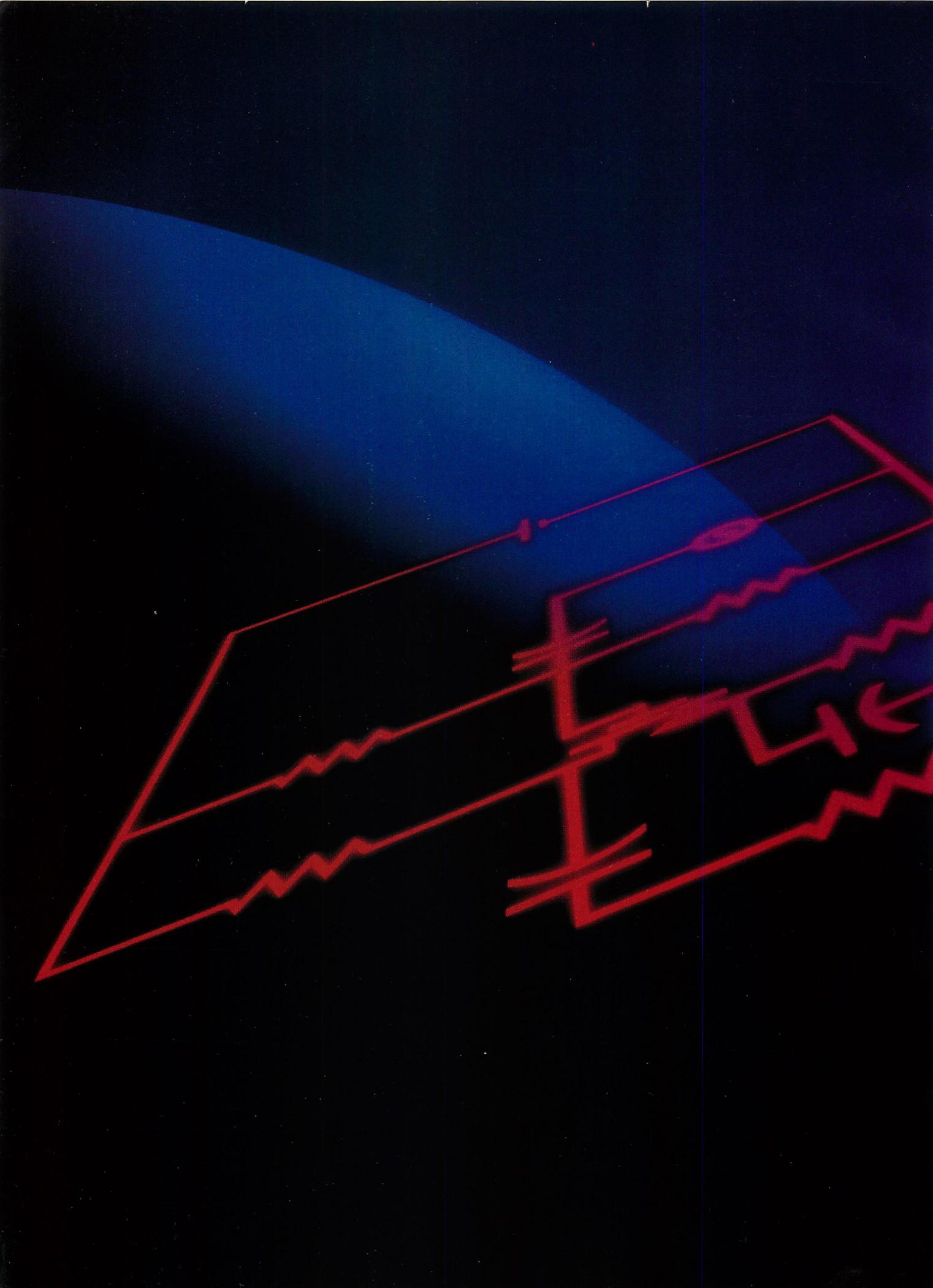
If a station has no message to send when it receives the token, it passes the token on to the next station. Each node in the network sends and receives all transmitted bits, regardless of whether the bits belong to data packets or to the token.

Token passing has several advantages over collision-detection protocols. Because a workstation cannot send a message unless it has the token, only one node at a time can transmit. This eliminates data collisions and the need for collision-detection and retry algorithms. Networks using token passing can be more easily expanded than those using CSMA/CD protocols. As more users are linked into a CSMA/CD network, the chance of transmission collisions will rise. This problem can be partially solved by increasing the rate of data transfer, but often the detection algorithm must also be reworked to accommodate a heavily loaded network. Token passing, on the other hand, allows increases in the data rate without software changes, as the token arbitrates the network.

A disadvantage of token passing is the ease with which service can be interrupted. In a real physical-ring topology, the token can get lost if one of the stations is down, because the ring has been broken. (MultiLink, which has a conceptual rather than a physical ring topology, will not exhibit this problem.)

Also, there is a delay of some microseconds at each node, while the station decides whether to pass the token on or to send a packet out. With many computers linked to the ring, there is a perceptible delay before the token arrives at a station and messages can be transmitted.





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# MICRO-CAP

program. With a simulator program, the theoretical circuit was specified and analyzed by the computer. All data points were generated internally and then scaled and plotted. This was much more convenient. Not only could the graphs and charts be produced almost effortlessly, but components from the keyboard could be changed and the circuit custom-fit and tuned to specific needs.

The simulator programs I worked with on large computers usually fell into either the analog or digital design category; today, however, some CAD/CAM types cover all design phases. Small computers are also well suited for this type of work because of their graphics capabilities.

Micro-Cap, the software described in this article, is an analog design program for electrical engineering work. It allows the user to "draw" a circuit on the screen and then analyze it using any of three techniques (transient, AC, or DC analysis). The results of a particular analysis can be typed as a long data table or can be presented graphically.

## WHAT'S IN THE PACKAGE

Micro-Cap (Microcomputer Circuit Analysis Program) is produced by Spectrum Software of Sunnyvale, California and is shipped on three S.S.D.D. diskettes with a professional-looking manual. The plastic tabs in the three-ring binder divide the manual into eight sections: Table of Contents, Designer Module, Analyzer Module, Transient Analysis, AC Analysis, DC Analysis, Component Models, and Appendices. Also provided is an Auto Demo diskette that enables the user to try out the programs without reading any of the manual. The circuits and graphs on the demo illustrate all of the basic features of the Micro-Cap program and allow the screen to be dumped to an IBM printer or a diskette file.

The other two disks are for use only after the manual has been read. The Circuit Analysis Program is inserted into drive A and the supplied

Data Diskette into drive B. The Data Diskette provided by Micro-Cap contains many sample circuits and diagrams to help describe the capabilities of the system and the methods of specifying and drawing circuits. Additional data diskettes can be created as the user's circuit library grows.

Before trying to design a cruise control for, say, a '57 Chevy, note that the number of components is limited. When I read the list of available components and their quantity I thought back to the Erector Set I had as a child. Initially, I thought I could

## NETLIST LOOP CIRCUIT

REF. NO.	COMPONENT NAME	CONNECTIONS				PARAMETER OR TYPE
		-	+	-	+	
1	BATTERY	0	1	0	0	32
2	RESISTOR	1	2	0	0	2
3	RESISTOR	2	3	0	0	4
4	BATTERY	0	3	0	0	20
5	RESISTOR	0	2	0	0	8

Table 1: The Components, Nodes, and Values for the Simple DC Circuit

build anything with four wheels, ten cross braces, eight structure beams, etc. However, it wasn't long before I was borrowing extra wheels from a friend to complete a car and trailer project. That kind of borrowing isn't possible with Micro-Cap. The program provides exactly

10 Batteries  
60 Resistors  
60 Capacitors  
40 Inductors  
1 User Source  
10 Switches  
20 Diodes  
20 Bipolar Transistors  
10 Transformers  
20 Mos Devices  
20 Opamps  
5 Sinusoidal Voltage Sources  
5 Programmable Voltage Sources  
10 Polynomial Sources  
This is not initially a serious limitation as there are hundreds of circuits that can be manipulated without

even coming close to running out of components. (For instance, 40 inductors is ample for most uses.)

## USING MICRO-CAP

One possible use for this program is in the classroom. I taught a sophomore-level electrical engineering course and laboratory for ten years before switching to the Computer Science department. Each time I taught the course I stressed visual analysis of data using graphs and charts, but I was always limited by the amount of work such graphic

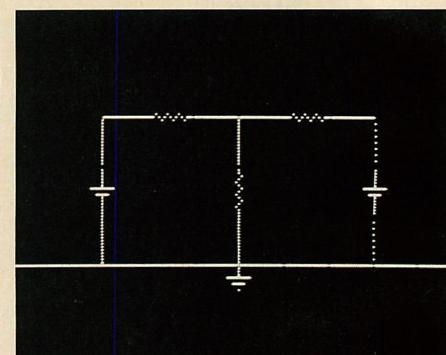


Figure 1: The Design of a Simple DC Resistor Loop Circuit

tools required. If Micro-Cap had been available at the time, I could have prepared circuits and graphs ahead of

**M**icro-Cap allows the user to "draw" a circuit on the screen and then analyze it using any of three techniques (transient, AC, or DC analysis). The results of a particular analysis can be typed as a long data table or can be presented graphically.

time for class. Students could also have used the program to analyze homework circuits, instead of repeatedly calculating data points and plotting them on a graph.

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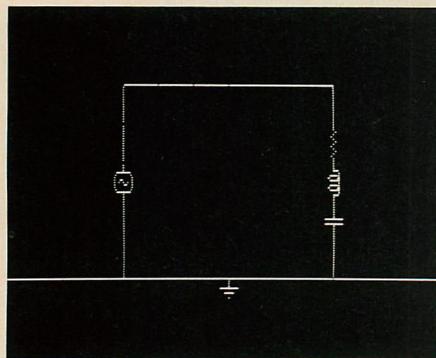
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# MICRO-CAP

To best illustrate how Micro-Cap works, I have chosen four basic analog circuits for analysis: a simple resistor network; a series resonance circuit; a transistor amplifier circuit; and a two-stage opamp circuit. These will be used to describe the functions of Micro-Cap's various stages.

## BUILDING THE CIRCUIT

All circuit design work begins with the Designer Module. This option is selected from the main menu upon booting the program. A high-resolution drawing screen will be presented



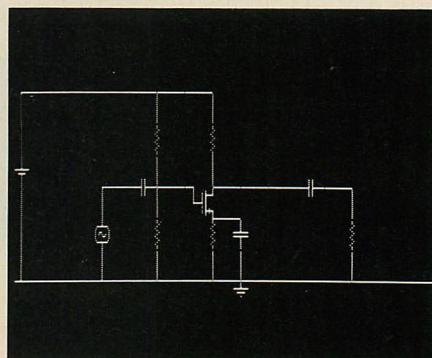
**Figure 2: The Design of a Series R-L-C Circuit**

upon which the user will build his or her circuit. The screen contains a cursor, a ground plane at the bottom of the screen, and a list of options in menu form. In this phase, the designer can move the cursor up, down, left, and right with the I, M, J, and K keys (this program does not support any special function keys). The menu also provides for (A)dding or (R)emoving components.

All cursor moves are made in either vertical or horizontal block jumps between "nodes." Each node is numbered but is entirely invisible on the screen. While using the Designer Module, the user will not know which node he or she is on. There are sixteen horizontal nodes and eight vertical nodes (not counting the ground plane). Since only one component can be inserted between a pair of nodes, the maximum circuit density is 120 components. The number of circuits is limited to the number that

can be entered on this screen since no provision has been made to couple multiple screen circuits.

One interesting feature of the Designer Module is that the user can choose either the Short or Line option. Both can be used to connect components between nodes. The Short option allows a piece of wire to be drawn between the node being used and any node immediately next to it. The Line option acts as a sort of wire spooler; with it a wire can be strung anywhere on the screen by using the I, J, K, and M keys. This fea-



**Figure 3: The Design of a One-Stage Transistor Amplifier**

ture also has a unique ability—it can string wire between nodes.

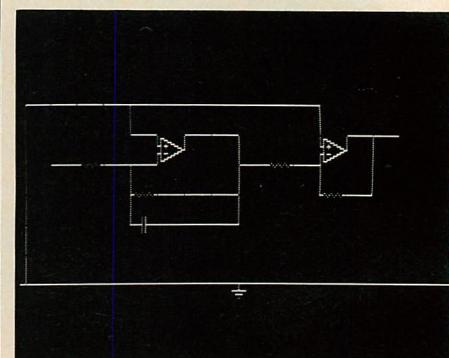
Figures 2, 3, and 4 were created with the Designer Module. Figure 1 is a simple resistor network with two batteries. As the components are entered, the value of the component must also be specified. Note, however, that this value is not shown on the screen. The node numbers and component values are actually stored in a file that is made available in the Analyzer Module. Normally, the resistor network shown in figure 1 would be analyzed by solving two simultaneous equations. I obtain my results by using the Transient Analysis option.

Figure 2 is a R-L-C circuit that will utilize the AC Analysis module to obtain a graph of gain versus frequency. Figure 3 is a one-stage NMOS transistor amplifier circuit. In designing this circuit, the NMOS transistor model (Type 0) was select-

ed from a list of standard components (see table 2). If one of the five standard types does not fit necessary specifications, the user can alter the inappropriate values during analysis.

The final circuit design is figure 4, which shows a two-stage opamp circuit. The first stage is a low-pass filter and the second stage is just an amplifier. For this circuit, standard opamps were again chosen from the list of standard components.

My initial reaction to using the Designer Module is that it is relatively easy to insert, remove, and connect



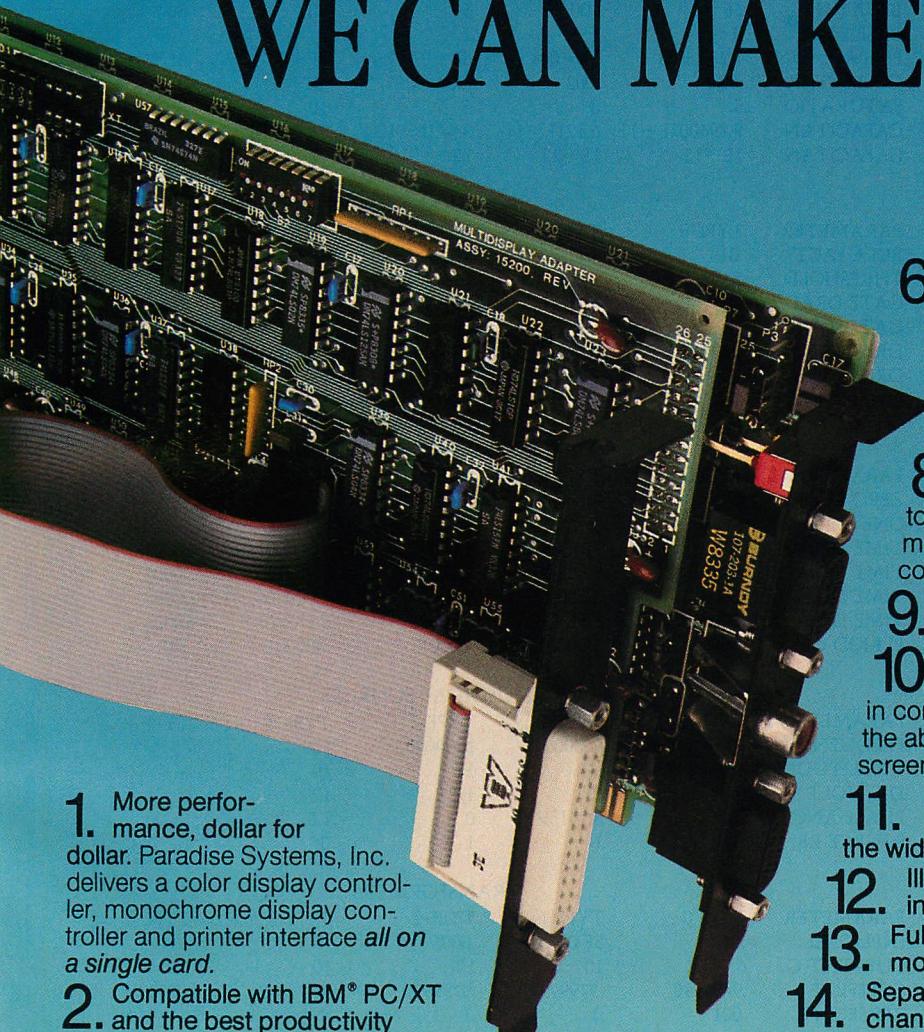
**Figure 4: A Two-Stage Opamp Circuit Design**

components on the high-resolution screen. The major drawbacks are lack of visible numbering of the screen nodes, limited circuit size (only one screen per circuit); and lack of component values on the screen. These drawbacks work against the user's ability to "free-hand" a circuit on the screen, because it is not possible to look directly at the component values without leaving the Designer Module; this forces the user to have a sketch of the circuit on paper. If the circuit must first be sketched on paper, what advantage is there to repeating it on the screen?

## RETRIEVING AND REVIEWING THE CIRCUIT

Once a circuit is created and saved using the Designer Module, it can be retrieved and reviewed using the Analyzer Module. From this module, circuit nodes and components are identified and altered and the three

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# MICRO-CAP

**Table 2: A Listing of the Standard Components Supplied by Micro-Cap**

options for analysis—Transient Analysis, AC Analysis, and DC Analysis—are called.

As an example, the resistor circuit of figure 1 is recalled (into memory) by using the RETRIEVE command from the analyzer menu. The components, nodes, and values can then be observed by using the REVIEW command as shown in table 1. I saved this circuit in a file called Loop Circuit. The components are listed in the order they were originally entered on the original circuit. The node numbers are listed under the "connections" column and the value of the components under the "parameter or type" column. Thus, one battery is connected between node 0 and node 1 and has a value of 32 volts. Next, a resistor connects between node 1 and node 2 and has a value of 2 ohms.

Now flip back and forth between the original circuit and this table; it is still difficult to understand where each node is located. The clue is the circuit sketch that the user made on paper. The node values can now be transferred onto this sketch, which has the circuit and the component values. This will help clarify what table 1 is referring to in terms of the circuit. Because of this confusion, the Designer Module is not as helpful as it could be to the designer.

Table 1 also shows seven editing features that are available at this time. Components can be changed for analysis by moving (U)P or (D)OWN the list. You can also (A)DD or (R)EMOVE components at this time. Component values are changed using the (E)DIT feature. These changes do not permanently affect the original circuit, however; they are used temporarily to fine tune components. When final values are obtained, they will have to be entered through the Designer Module.

When this table is satisfactory,

PARAMETER	TYPE 0	TYPE 1	TYPE 2	OPAMPS	TYPE 3	TYPE 4
INPUT RES	1000000	100000	1000000	10000	100000	1000000
OPEN LOOP	1000	1000	100	2000	10000	10000
OUTPUT RE.	100	100	100	1000	200	.001
INPUT OFF	.0001	.0001	.001	.002	.001	.001
MAXIMUM 0	30	30	10	30	30	30
OUTPUT CA	5E-08	5E-08	5E-09	1E-08	1E-08	1E-08
DIODES						
PARAMETER	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4	
SATURATIO	1E-13	1E-12	1E-14	1E-13	1E-15	
ZENER VOL	130	200	60	5	5	
ZENER RES	10	20	10	10	10	
SERIES RE	10	1	1000	10	10	
VT TERM	.026	.026	.025	.026	.025	
PARALLEL	1000000	10000	1000000	10000	10000	
BIPOLAR TRANSISTORS						
PARAMETER	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4	
BETA (HFE)	66	100	50	40	50	
BASE EMIT	0	1	2	2	1	
F-TAU=UNI	1.25E+08	2E+08	5E+07	8E+07	5E+08	
COLLECTOR	.002	.002	.003	.01	.002	
SATURATIO	5	3	5	10	5	
CAPACITAN	9.794001E-11	6.121E-11	3.672E-10	7.651001E-10	2.448E-11	
CAPACITAN	1E-12	1E-12	1E-11	1E-11	1E-12	
MOS TRANSISTORS						
PARAMETER	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4	
BETA FACT	.01	.01	.001	.001	9.999999E-06	
THRESHOLD	2	-2	-2	2	2	
GATE-DRAI	1E-11	1E-11	1E-11	1E-11	5E-13	
GATE-SOUR	1E-11	1E-11	1E-11	1E-11	1E-12	
DRAIN-SOU	100000	100000	100000	100000	100000	
DRAIN-SOU	1E-11	1E-11	1E-11	1E-11	1E-12	
LINEAR TR	.05	.05	5.000001E-03	5.000001E-03	.00005	
PROGRAMMABLE WAVEFORMS						
PARAMETER	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4	
ZERO LEVE	0	0	0	.5	0	
ONE LEVEL	5	5	5	5	5	
TIME DELA	1E-08	1E-08	.000002	.0000001	.0001	
TIME DELA	.00001	2.55E-07	.000003	1.1E-07	.0002	
TIME DELA	.0000012	.0000005	.000007	.0000005	.0005	
TIME DELA	.0000013	7.5E-07	.000008	5.1E-07	.0006	
PERIOD OF	.00002	.000001	.00001	.000001	.001	
SINUSOIDAL SOURCES						
PARAMETER	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4	
FREQUENCY	60	500000	2000000	100	85	
AMPLITUDE	60	.5	1	10	616	
D.C. VOLT	0	0	1	10	0	
PHASE ANG	0	3.14159	0	1.5	0	
SOURCE RE	.1	1	1	.1	.1	
TRANSFORMERS						
PARAMETER	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4	
INPUT SEL	.01	5E-08	.0005	10	10	
CURRENT G	6	10	10	10	10	
COEFFICIE	.9899999	.9799999	.9799999	.9799999	.9799999	
RES-SECON	.001	.1	.1	.1	.1	
POLYNOMIAL SOURCES						
PARAMETER	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4	
A	-1	0	0	0	1	
B	0	-.001	-.001	-.001	1	
C	0	1	1	1	1	
D	1	-.001	0	0	-1	
E	2	2	0	0	2	
F	0	0	0	0	-1	
G	0	0	0	0	3	

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## ANALYSIS LIMITS

PRESS <RETURN> TO ACCEPT  
DEFAULT VALUES OR TYPE  
DESIRED VALUE & PRESS  
<RETURN>

MAXIMUM SIM TIME (SEC)	1
MAXIMUM DELTA TIME (SEC)	.1
MINIMUM ACCURACY (%)	5
UPPER TRACE NODE(S)	1/2/V
OFFSET FOR #1	0
SCALE FACTOR FOR #1	3
LOWER TRACE NODE(S)	1/2/P
OFFSET FOR #2	0
SCALE FACTOR FOR #2	4

ARE THESE CORRECT (Y/N)?

**Table 3: Parameters for the Transient Analysis of the Simple DC Circuit**

## ANALYSIS LIMITS

PRESS <RETURN> TO ACCEPT  
DEFAULT VALUES OR TYPE  
DESIRED VALUE & PRESS  
<RETURN>

LOWEST FREQUENCY	100
HIGHEST FREQUENCY	1E+09
LOWEST GAIN	1
HIGHEST GAIN	1000
INPUT NODE NUMBER	1
OUTPUT NODE NUMBER	4
MIN ACCURACY (%)	2
HIGHEST PHASE SHIFT	360
LOWEST PHASE SHIFT	-360

ARE THESE CORRECT (Y/N)?

**Table 4: Parameters for the AC Analysis of the R-L-C Circuit**

## NETLIST RESONANCE CIRCUIT

REF. NO.	COMPONENT NAME	CONNECTIONS				PARAMETER OR TYPE
		IN	-	+	OUT	
1	RESISTOR	2	3	0	0	5
2	INDUCTOR	3	1	0	0	4E-3
3	CAPACITOR	1	0	0	0	.1E-6
4	VSIN	0	2	0	0	100

U=UP D=DOWN E=EDIT R=REMOVE P=PRINTER Q=QUIT

**Table 5: Components, Nodes, and Values for the R-L-C Circuit**

## NETLIST TRANS CIRCUIT

REF. NO.	COMPONENT NAME	CONNECTIONS				PARAMETER OR TYPE
		IN	-	+	OUT	
1	VSIN	0	1	0	0	1
2	RESISTOR	2	0	0	0	20E3
3	RESISTOR	2	6	0	0	80E3
4	RESISTOR	5	6	0	0	6E3
5	RESISTOR	3	0	0	0	2E3
6	CAPACITOR	3	0	0	0	100E-6
7	RESISTOR	4	0	0	0	6E3
8	BATTERY	0	6	0	0	10
9	NMOS TRANS	6	2	3	5	0
10	CAPACITOR	1	2	3	5	1E-8
11	CAPACITOR	5	4	3	5	1E-8

U=UP D=DOWN E=EDIT R=REMOVE P=PRINTER Q=QUIT

**Table 6: Components, Nodes, and Values for the Transistor Amplifier Circuit**

the user can obtain a (P)RINTED copy before (Q)UITTING and running an analysis program.

Tables 5, 6, and 8 correspond to figures 2, 3, and 4. Table 6 shows the

VSIN source as a "type 1" component. In the case of standard components, this number refers not to the value of the component but to the component's particular type as taken

from table 2. Try this small challenge: using table 6 and figure 3, transfer the node values from the table to the circuit. Keep in mind that this is a simple circuit.

## TRANSIENT ANALYSIS

From the Analyzer Module we'll select a Transient Analysis option for figure 1. A menu is presented with preset default values for the analysis limits. Table 3 shows redefined values for this analysis. The maximum simulation time is set to one second. The delta time refers to how many points are to be considered. In this case, calculations will be made every tenth of a second. The figure for accuracy limits the amount of voltage variation permissible in the analysis. The Transient Analysis option will allow us to view two parameters. We can select two components or use one component and record two values.

For figure 1, I chose to view the voltage and power in the 2-ohm resistor. I did this by specifying the values (1/2/V) and (1/2/P). The (1/2) obviously means the component between nodes 1 and 2. This analysis option will permit the graphing of voltage, current, power, and energy for any component value.

When the values for the analysis are correct, type (Y) to enter the graphing stage. The results are shown in figure 5. These results, as seems logical, do not change with time. The voltage across the resistor is 8 volts and the power developed in the resistor is 32 watts. If the values were plotted off scale, the program could be run again using an offset value to bring the plot within range.

The Transient Analysis option is actually much more useful for natural and forced response problems involving transient conditions. I chose this example, however, to show that the Micro-Cap program could be used for even the simplest DC Circuits.

## AC ANALYSIS

The AC Analysis option allows the user to examine the output of a cir-

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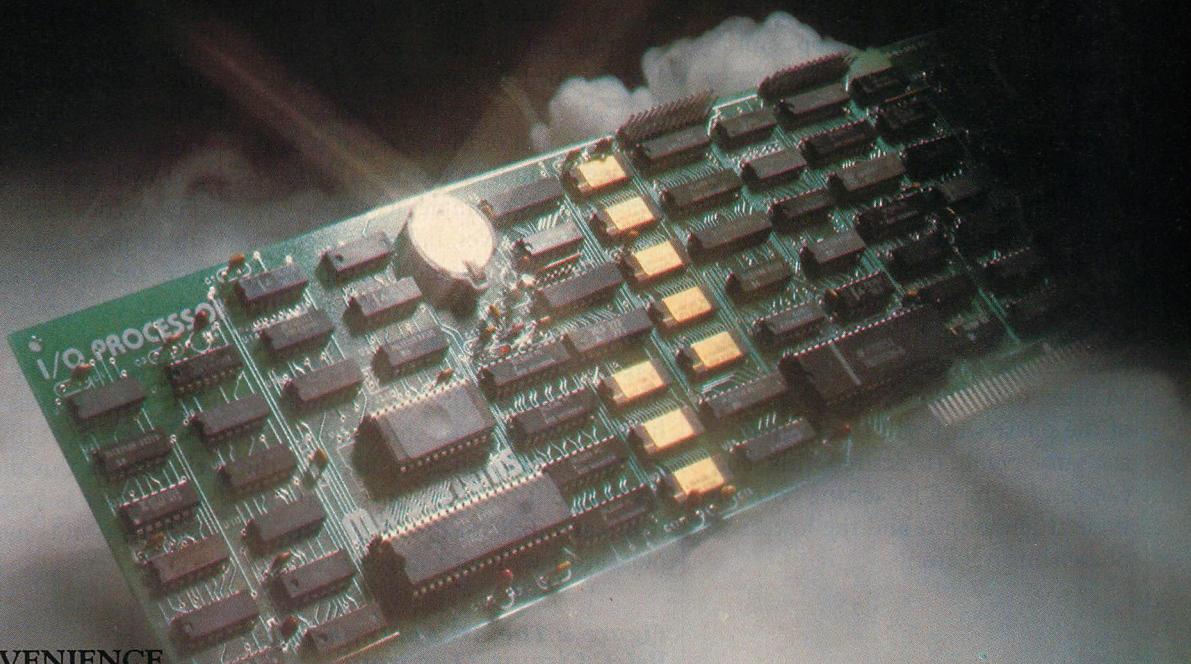
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# MICRO-CAP

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DEFAULT VALUES OR TYPE  
DESIRED VALUE & PRESS  
<RETURN>

LOWEST FREQUENCY	100
HIGHEST FREQUENCY	100,000
LOWEST GAIN	.01
HIGHEST GAIN	100
INPUT NODE NUMBER	2
OUTPUT NODE NUMBER	1
MIN ACCURACY (%)	5
HIGHEST PHASE SHIFT	360
LOWEST PHASE SHIFT	-360

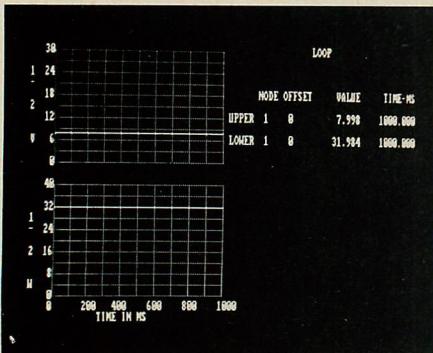
ARE THESE CORRECT (Y/N) ?

**Table 7: Parameters for the AC Analysis of the R-L-C Circuit**

cuit that is subjected to a changing frequency on its input. Table 4 shows the analysis limits for the circuit in figure 2. The user has the option to select the lower and upper frequency ranges (multiples of ten only) and the lower and upper gains (multiples of ten only). Nodes are referenced to the ground bus, and therefore only one number is specified.

For the analysis of the R-L-C circuit, the input is between the ground node and node 2. I chose the output between the ground and node 1. In addition to the plot of the gain, a plot of the phase shift will be drawn on the same graph. (If desired, this plot can be eliminated by setting both the highest phase shift and the lowest phase shift to zero.)

**Figure 5: A Transient Analysis of the Loop Circuit**



## NETLIST OPAMP CIRCUIT

REF NO.	COMPONENT NAME	CONNECTIONS				PARAMETER OR TYPE
		IN -	IN +	OUT -	OUT +	
1	OPAMP	1	0	0	2	1
2	OPAMP	3	0	0	4	1
3	CAPACITOR	1	2	0	0	1E-7
4	RESISTOR	5	1	0	0	500
5	RESISTOR	1	2	0	0	1000
6	RESISTOR	2	3	0	0	1500
7	RESISTOR	3	4	0	0	2000

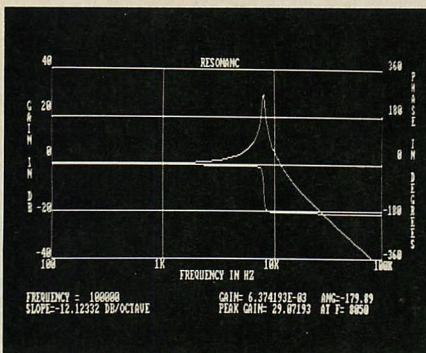
U=UP D=DOWN E=EDIT R=REMOVE P=PRINTER Q=QUIT

**Table 8: Components, Nodes, and Values for the Opamp Circuit**

Figure 6 shows the results of this analysis. The peak gain was obtained at the resonant point ( $f=8050$  hertz), according to the program. My calculator yielded a frequency of 7,958 hertz; the error is within 2 percent. Note the plot of the phase shift as it changes from 0 to about  $-180$  degrees. In this example, it was easy to see the two curves, but a different plotting symbol would be helpful.

Figure 7 shows the same type of analysis for the transistor amplifier stage. If the analysis had been conducted between 10K and 1M hertz, how could the phase shift and the gain be distinguished? In figure 9, the result of our two-stage opamp circuit, it is really difficult to tell the two plots apart without using the legend.

**Figure 6: The AC Analysis of the R-L-C Circuit. (The word resonance is cut off because Micro-Cap will print only eight characters of a label.)**



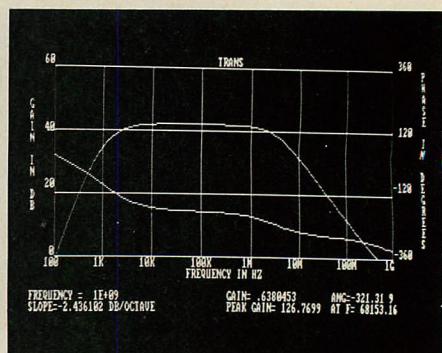
This problem should be addressed by Micro-Cap.

In these graphs, the frequency is plotted on a logarithmic axis. The user can include "minor grids," which are the increments between the major lines. They tend to produce a crowded graph that is hard to read. The vertical axis appears only as a linear plot. Actually, it is logarithmic, since DB values are obtained by taking the logarithm of a gain ratio.

## DC ANALYSIS

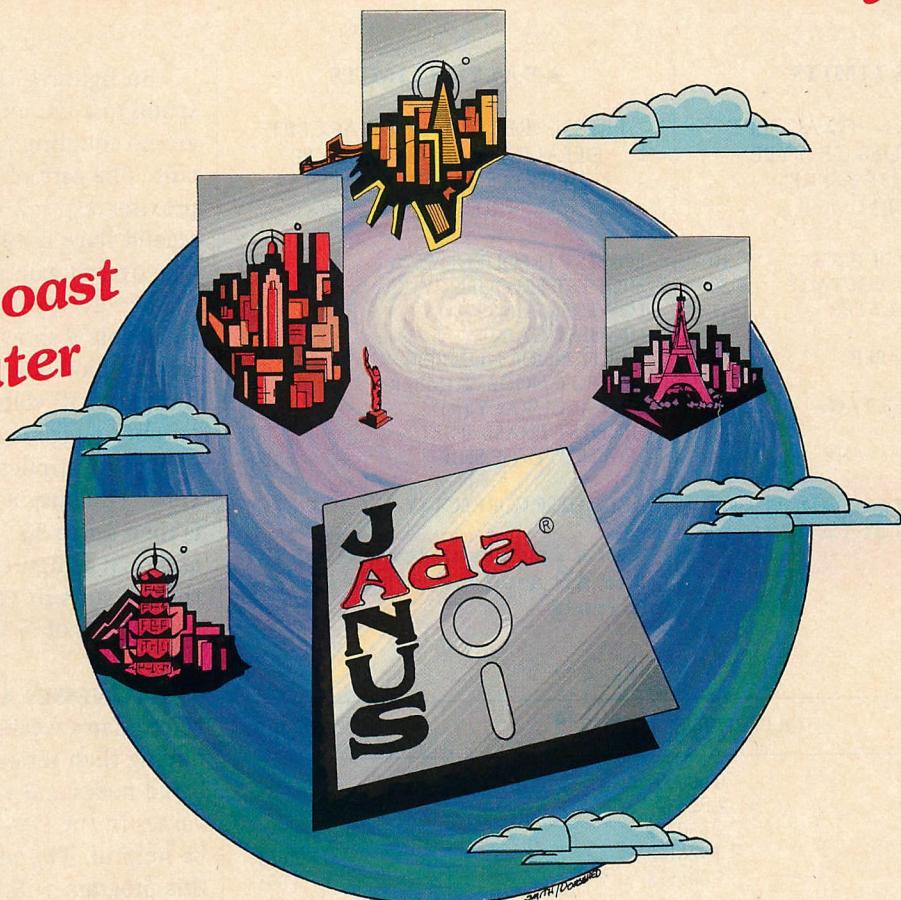
The DC Analysis mode permits the DC analysis of linear and non-linear circuits. In this mode an increasing DC voltage is entered in one node and the results monitored in another.

**Figure 7: The AC Analysis for the One-Stage Transistor Amplifier**



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# MICRO-CAP

## ANALYSIS LIMITS

PRESS <RETURN> TO ACCEPT  
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DESIRED VALUE & PRESS  
<RETURN>

MAXIMUM INPUT VOLTAGE	10
MAXIMUM OUTPUT VOLTAGE	30
MAXIMUM VOLTAGE STEP	.1
INPUT NODE #	5
OUTPUT NODE NUMBER	4
NO. OF ITERATIONS	2
STARTING INPUT VOLTAGE	0

ARE THESE CORRECT (Y/N)?

**Table 9: Parameter Values for the DC Analysis of the Opamp Circuit**

## ANALYSIS LIMITS

PRESS <RETURN> TO ACCEPT  
DEFAULT VALUES OR TYPE  
DESIRED VALUE & PRESS  
<RETURN>

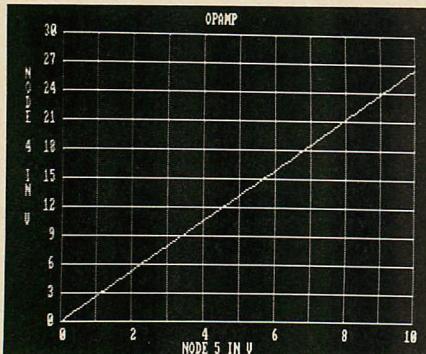
LOWEST FREQUENCY	1
HIGHEST FREQUENCY	100,000
LOWEST GAIN	.01
HIGHEST GAIN	100
INPUT NODE NUMBER	5
OUTPUT NODE NUMBER	4
MIN ACCURACY (%)	5
HIGHEST PHASE SHIFT	0
LOWEST PHASE SHIFT	-180

ARE THESE CORRECT (Y/N)?

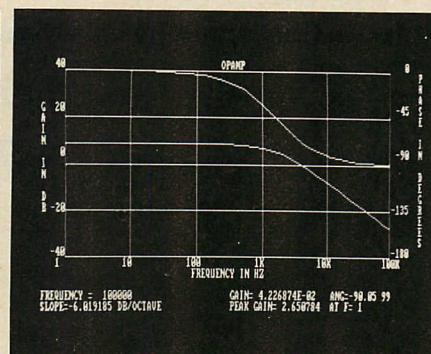
**Table 10: Parameter Values for the AC Analysis of the Opamp Circuit**

INPUT VOLTAGE	OUTPUT VOLTAGE	SLOPE
0.000000	0.00000	2.651
.499999	1.32539	2.651
.999998	2.650779	2.651
1.499997	3.976168	2.651
1.999996	5.301558	2.651
2.499995	6.626947	2.651
2.999994	7.952337	2.651
3.499993	9.277727	2.651
3.999992	10.60312	2.651
4.499991	11.92851	2.651
4.99999	13.2539	2.651
5.499989	14.57929	2.651
5.999988	15.90467	2.651
6.499987	17.23006	2.651
6.999986	18.55545	2.651
7.499985	19.88085	2.651
7.999984	21.20623	2.651
8.499983	22.53162	2.651
9.499981	25.1824	2.651
9.999979	26.50779	2.651

**Table 11: Tabular Results of the DC Analysis of the Opamp Circuit**



**Figure 8: The DC Analysis for the Opamp Circuit**



**Figure 9: The AC Analysis for the Opamp Circuit**

In figure 4, the opamps will respond to a DC analysis because there are no coupling capacitors in the circuit. The gain of the first stage is approximately -2 while that of the second stage is approximately -1.33. The overall gain for DC analysis is then  $(-2) \times (-1.33) = +2.66$ .

Table 9 shows the analysis limits for this plot. The input voltage is limited to 10 volts, and therefore the output voltage is expected to be input voltage multiplied by gain, or 26.66 volts. The output voltage (maximum) is then set to 30. The resulting graph is shown as figure 8. Table 11 shows these results in tabular form (with increments of .5 volt).

## WEAKNESSES AND STRENGTHS

Micro-Cap's weaknesses are more annoying than serious. Visible, numbered nodes and visible component values in the Designer Module would be helpful. The major limitation of this program will be the limited size of the circuit that can be viewed. If the user is willing and able to break the circuit into modules for analysis, this will not be a severe limitation.

I would rank Micro-Cap very highly in several areas: the manual is well written and the programs do what they say they'll do; the analysis programs are fast and they produce professional-quality graphs; anticipating that not everyone owns an IBM printer, Micro-Cap allows graphs to be stored on disks so that another screen-dump program can be used. I think Micro-Cap would be an asset to any technical or engineering school, especially if a large mainframe circuit simulator program is not available for use.

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Let's take a look at the Lab Master. It consists of a full-size mother board (see figure 1) that is plugged into one of the PC's slots, plus a metal box (approximately 10" x 2" x 6") containing the daughter board, which is connected to the mother board by a 50-conductor ribbon cable about 3

feet long. A/d conversions are performed on the daughter board, while all other functions are handled on the mother board. This arrangement has the advantage of allowing the a/d converter to be located near the source of the signal and outside the electrically noisy environment of the PC's cabinet (the ribbon cable between the mother and daughter boards can be greatly extended).

Packed into the mother and daughter boards are sixteen single-ended or eight differential a/d channels, two d/a channels, five to sixteen bit timers/counters, and twenty-four digital input/output lines.

## ANALOG-TO-DIGITAL CONVERTER

The Lab Master's standard a/d converter has a rated maximum conversion rate of 30KHz, although mine operates at 40KHz with complete reliability. The full-scale input range is jumper selectable for 0 to +10v or -10 to +10v; it is a 12-bit converter, meaning that its resolution is one part in  $2^{12}$ , or 1/4096 of the full-scale range. This means, for example, that an input signal of 0 to +10v will be measured with an accuracy of ap-

proximately 0.0025v.

The a/d converter has an autoincrementing feature that can free the software from the necessity of specifying the input channel to convert for each conversion. When autoincrementing is enabled (via a software command), the a/d converter will automatically cycle between a starting channel (specified by software) and a final channel (set with a DIP switch on the daughter board).

In addition to its input range, several other operating parameters of the a/d converter must be selected by installing jumpers over pins on the daughter board. These parameters include single-ended or differential inputs, output data format (two's complement or binary), and others, covered in the instruction manual.

There are a number of extra-cost a/d options available: expansion to 256 input channels; software-programmable gain up to 500; hardware-selectable (via a resistor placed on the daughter board) gain up to 2000; 14- or 16-bit conversion accuracy; and 100kHz maximum conversion rate. Some of these options are mutually exclusive, however; 14 and 16 bit converters are limited to maximum

conversion rates of 10 and 2.5 kHz, respectively. In addition, input gains greater than 10 require that a capacitor be placed on the daughter board to allow for longer amplifier settling times. This reduces the maximum conversion rates: e.g., 20 kHz at a gain of 100 and 3.8 kHz at a gain of 1000.

## CONVERTERS AND TIMER/COUNTER

The Lab Master has two independent d/a converters (DAC80s). Each converter has a 12-bit input, 5-microsecond settling time, and jumper selectable output ranges of -2.5 to +2.5, -5 to +5, -10 to +10, 0 to +5, or 0 to +10 volts.

The Lab Master's timing and counting functions are provided by an AM9513 LSI chip. This is an extremely sophisticated chip that can provide almost any conceivable timing or counting function, if the required programming can be figured out. It consists of five general-purpose

16-bit counters, frequency dividers, and a variety of special-purpose registers. Some of the tasks that can be accomplished with this chip are the time of day, an external-event counter, and the generation of complex timing patterns.

The 9513 is accessed through only two ports: a data port and a control port. Inside the 9513 are, by my count, 20 control and data registers that must be accessed through these two ports (see figure 2). This is done by sending a command specifying one of the internal registers, and then sending a read or write command. This system works, but it leads to some rather complex programming.

## PARALLEL PORTS

There are twenty-four parallel digital input/output lines on the Lab Master, provided by an Intel 8255. These lines can be programmed as groups of eight or as groups of twelve. There are three modes of operation avail-

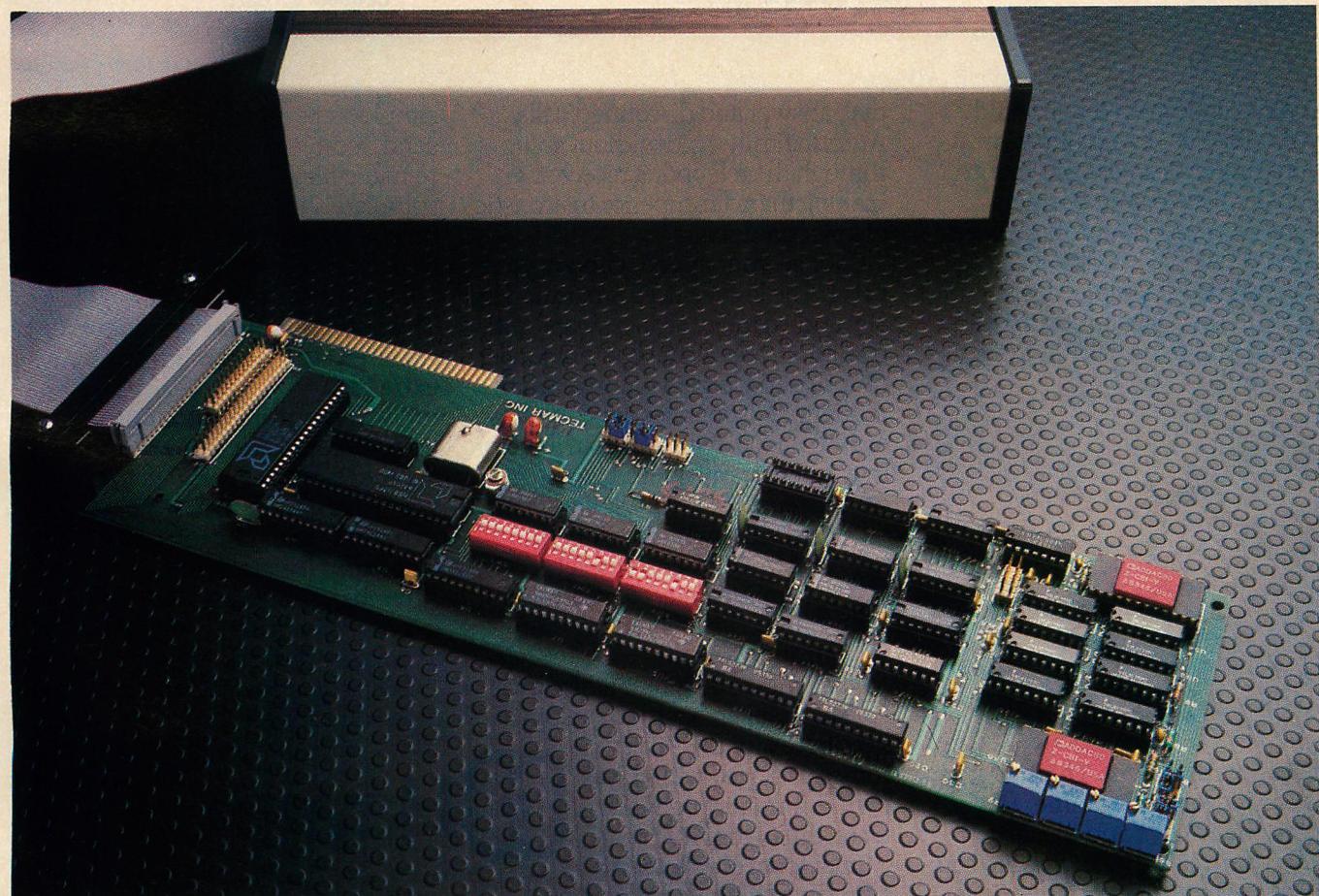
able: three input or output ports, two input or output ports with handshaking, or a bidirectional I/O port with handshaking (see table 1).

## INTERRUPTS

An interrupt allows the processor to respond to a signal from an external device without having to constantly check ("poll") to see if the signal has been sent. When a signal is received on an interrupt line, the processor saves the relevant information about its current task and then executes a series of software instructions located at a predetermined memory location. These instructions, called an interrupt handler, perform the tasks needed to "service" the interrupt, and the processor then resumes the task that was interrupted.

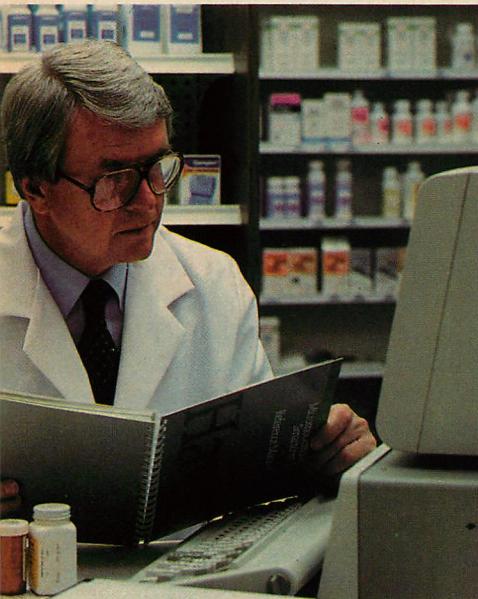
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*Peter Aitken is a research associate in the Department of Physiology at the Duke University Medical Center, Durham, NC. His PC-aided research involves the use of animal models for the study of epilepsy.*

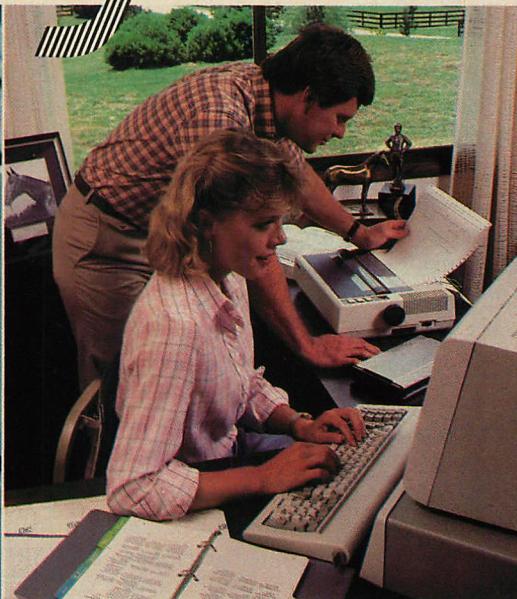


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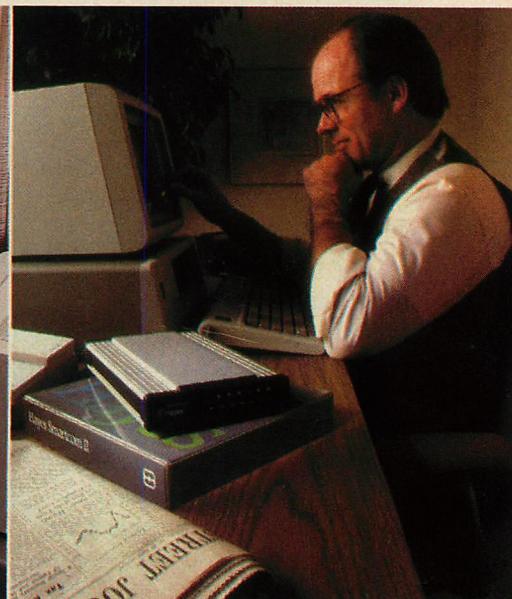
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And, in addition to the IBM PC, Smartcom II is also available for the DEC Rainbow™ 100, Xerox 820-II™ and Kaypro II™ personal computers.

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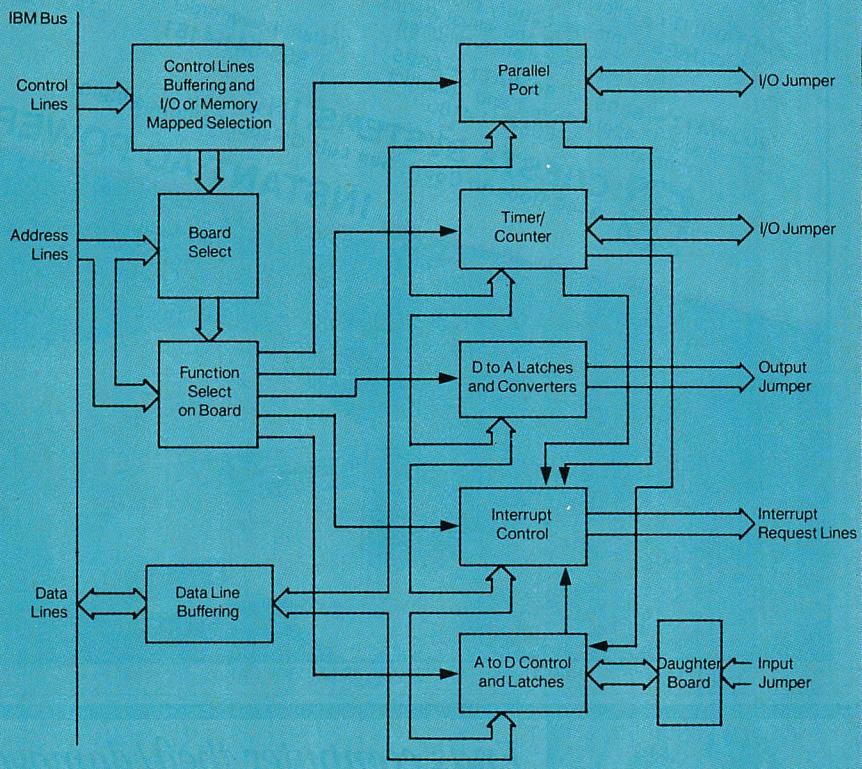
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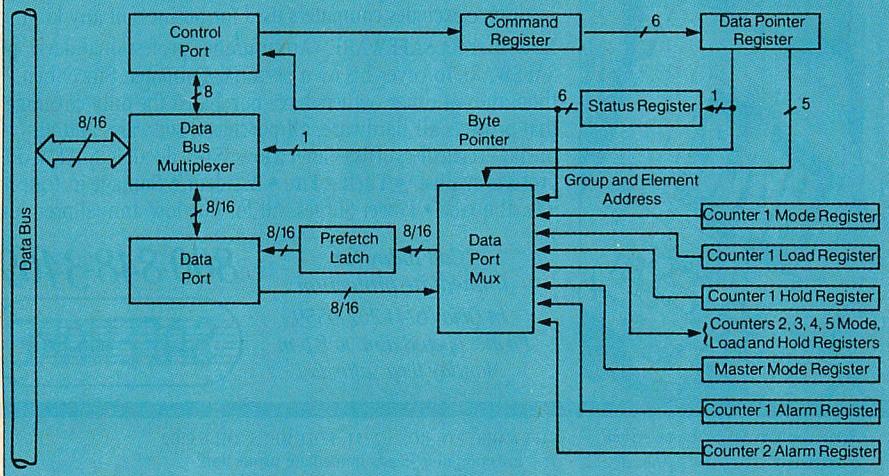
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# LAB MASTER

**Figure 1: Block Diagram of Lab Master Mother Board. (Reprinted from the Tecmar Lab Master Board manual by permission of Tecmar Inc.)**



**Figure 2: Block Diagram of Register Access for 9513 Timer.**  
(Reprinted from the Tecmar Lab Master Board manual by permission of Tecmar Inc.)



The Lab Master allows access to interrupt lines 2 through 7 in the PC and permits interrupts to be generated by the a/d converter, timer, or parallel ports. Thus, as many as six interrupt service routines can be in place at one time. Interrupt sources

are joined to interrupt lines with jumpers on the mother board.

The interrupt feature can be extremely useful. For example, imagine an application requiring that an a/d conversion be done once per second over a long period. The Lab Master

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## LAB MASTER

could be configured so that one of the clocks caused an interrupt once per second, jumping to an interrupt-handler routine that initiated an a/d conversion and stored the data in memory. Since this task would require only a few milliseconds out of each second of the computer's time, the computer can be busy with another task—such as data processing or program editing—with the time spent collecting data not even noticed by the operator.

Some confusion may result from the fact that the IBM PC interrupt lines (IRQ2 through IRQ7) are numbered differently from the 8088's interrupt types: the PC's interrupt line IRQ2 is not an 8088 type-two interrupt. This fact is not mentioned in the Lab Master manual, but a call to Tecmar revealed that the 8088 interrupt type is the IRQ number plus eight, and the vector table address for a given interrupt type is equal to the interrupt type times four. Thus, a signal on IRQ line five will generate a type-13 interrupt, causing a jump to the interrupt-service routine whose starting address is stored in the interrupt vector table at memory locations 00034H (instruction pointer) and 00036H (code segment). See *The 8086/8088 Primer* by S. P. Morse (Hayden Book Co., 1982).

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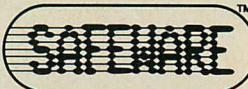
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## PROGRAMMING

The Lab Master may be configured in a memory mapped or an I/O mode. In the memory mapped mode, it appears to the computer as 16 consecutive memory locations; in the I/O mode it appears as 16 consecutive I/O ports. The board comes from the factory in the I/O mode with starting address 0710H. These 16 ports are the computer's means of communicating with the Lab Master; through them, data and status can be input from the board and control commands can be output to the board. Only two software commands are needed to use the Lab Master; in BASIC, these are INP and OUT (for the I/O mode) or PEEK and POKE (for the memory mapped mode).

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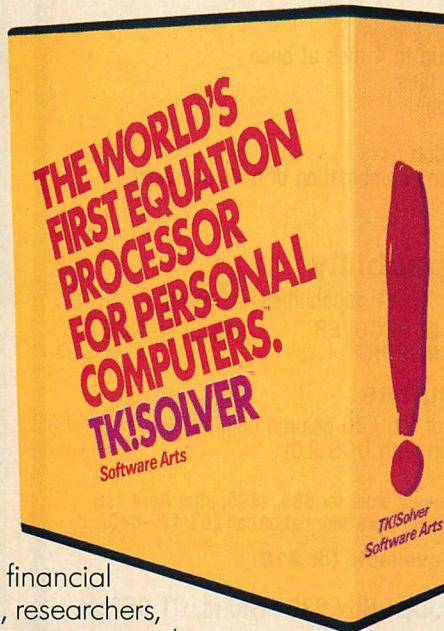
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# LAB MASTER

**Table 1: Tecmar Lab Master Port Assignments**

STARTING ADDRESS	PLUS	READ	WRITE
0		*	low 8 bits for D/A #0
1		*	the low 4 bits of this byte are the high 4 bits for D/A #0
2		*	low 8 bits for D/A #1
3		*	the low 4 bits of this byte are the high 4 bits for D/A #1
4		Status byte—individual bits indicate status of specific board functions.	Control byte—individual bits control certain board functions.
5		Low A/D data byte	A/D channel number to convert
6		High A/D data byte	Software start conversion—writing anything to this location initiates an A/D conversion.
7		*	Timer interrupt acknowledge
8		Read data port of 9513 timer	Write to data port of 9513 timer
9		Read control port of 9513 timer	Write to control port of 9513 timer
10		*	*
11		*	*
12		Parallel port A input	Parallel port A output
13		Parallel port B input	Parallel port B output
14		Parallel port C input	Parallel port C output
15		*	Parallel port control byte

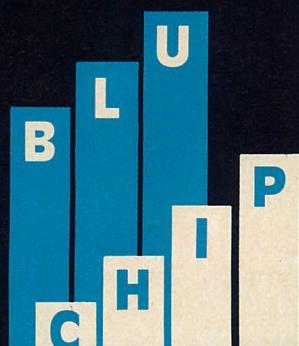
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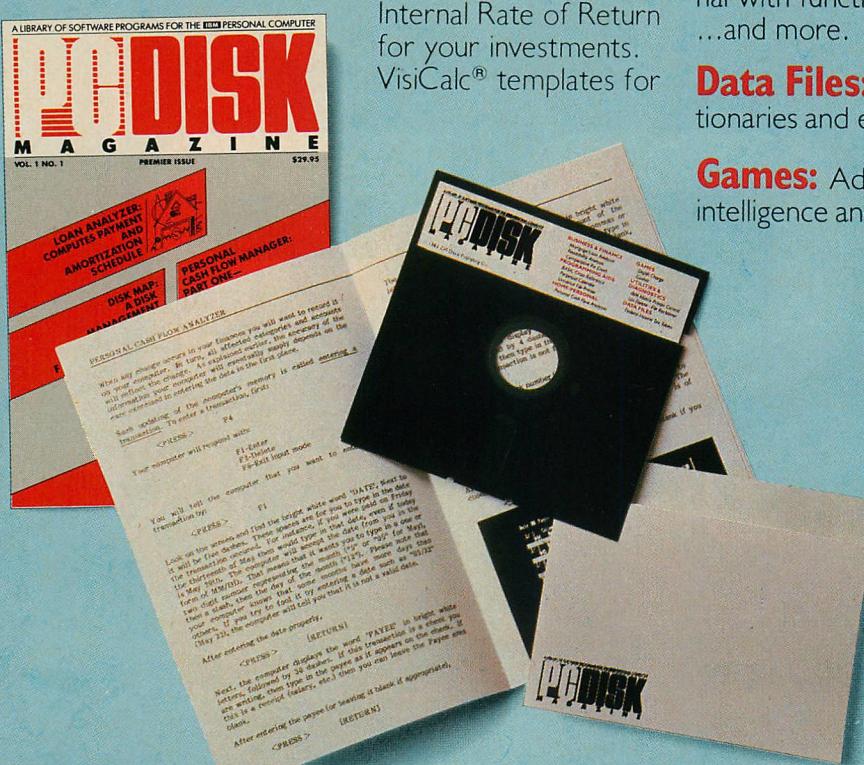
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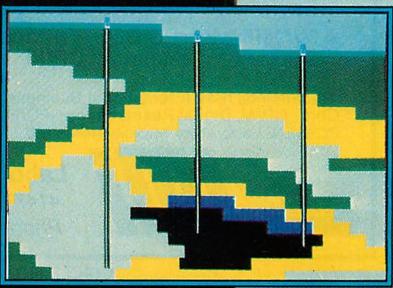
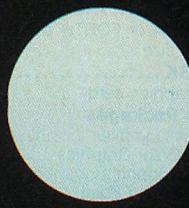
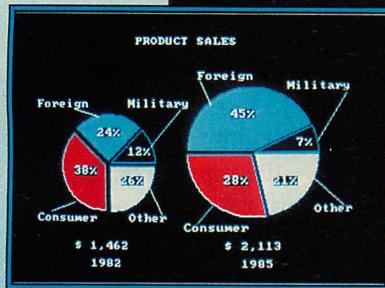
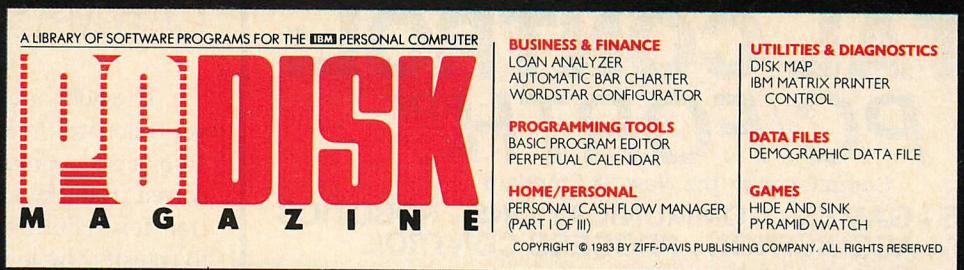
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# LAB MASTER

The 8088 uses an 8-bit data path, yet there are times when 12, 14, or 16 bits of data must be sent to or received from the Lab Master. Such transfers require two commands, one to transfer the lower 8 bits and one to transfer the higher 8 bits. Thus, for example, to input a value from the a/d converter the following steps must be taken (assuming that the Lab Master is I/O-mapped at starting address 0710H and is jumpered for a -10 to +10v input range and two's complement data):

**90 REM—start a conversion**

**100 OUT 0716H,0**

**110 REM—bit 7 of status byte set  
(i.e., conversion done)?**

**120 IF INP (0714H) THEN 120**

**130 REM—not get the data**

**140 LOW.DATA=INP(0715H)**

**150 HI.DATA=INP(0716H)**

**160 REM—convert from two's  
complement to a voltage -10  
to +10**

**170 VOLTS=(256\*HI.DATA)+  
LOW.DATA**

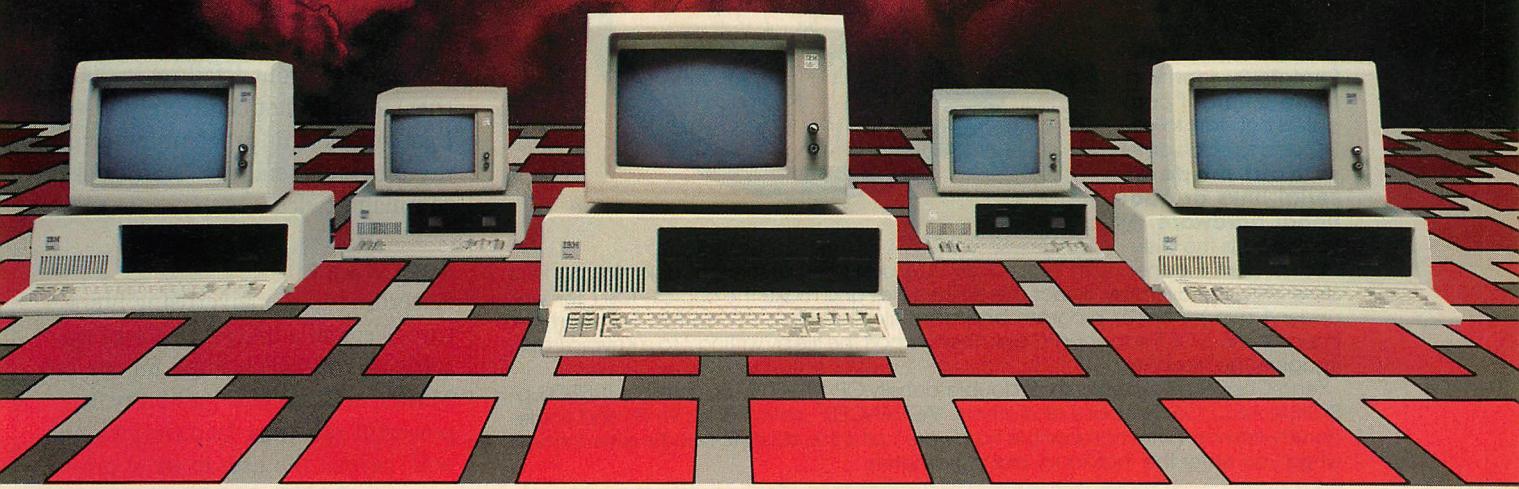
**180 VOLTS=VOLTS/204.8**

When programming in assembly language, the two necessary byte transfers can be accomplished with one IN or OUT command.

### THE MANUAL

The installation and instruction manual for the Lab Master is sized to fit in one of IBM's binders. In general, it is clear and complete, although there are areas in which some more information would be welcome (e.g., on programming interrupts). Several sample programs (all in BASIC) are provided. The one major weak point of the manual is the section on the 9513 timer/counter. As mentioned before, this device is rendered somewhat difficult to program by its two-port configuration and by the complexity of the functions available. The manual seems to provide all the needed information, but it is hard to understand. Particularly helpful here would be a number of sample programs for setting up the 9513 to do a variety of the most common tasks.

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## LAB MASTER

### PERFORMANCE

The Lab Master in this laboratory has been in fairly constant use for almost a year now. We have used most of the functions, and, with one exception, the Lab Master has performed perfectly. This one exception involves the 9513 timer chip; occasionally (perhaps once in 300 tries) the chip would not obey a software command to start a clock running. The people at Tecmar felt that this problem was internal to the 9513 itself, and they sent me a replacement chip. Installing the new 9513 reduced the problem (to about 1 failure in 2000 tries), but did not completely solve it. I got around this problem by having my programs send the "start clock" command twice.

### SOFTWARE

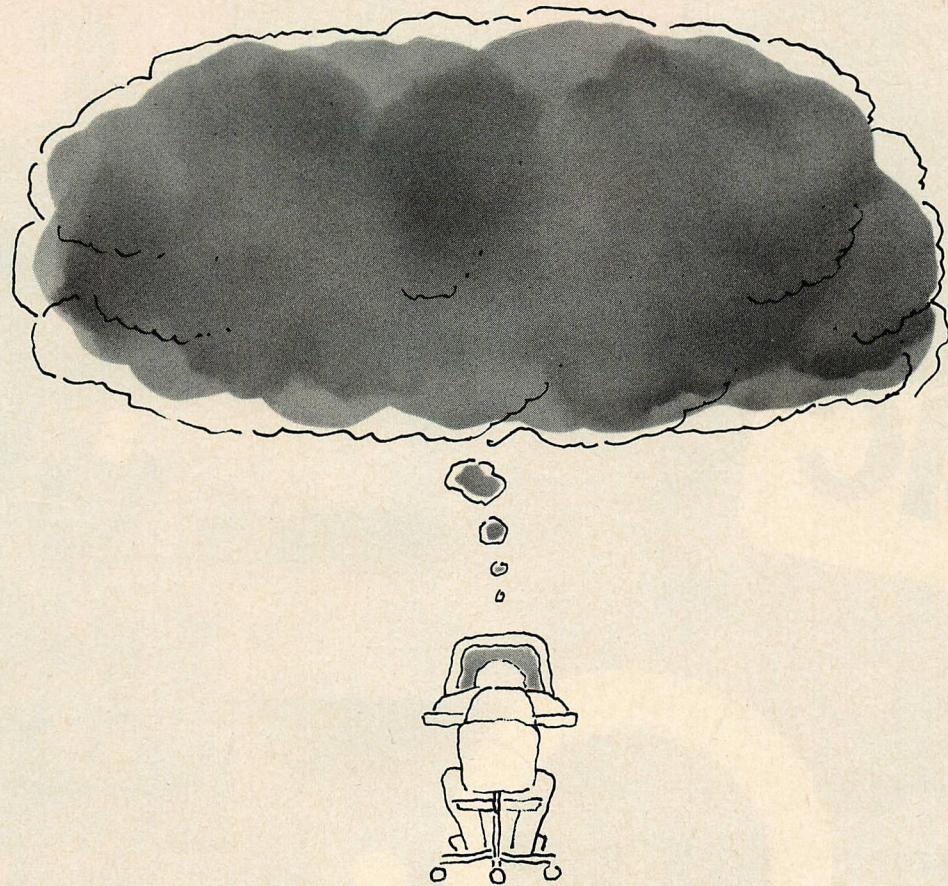
According to the advertising literature, Tecmar's LABPAC, a package of software routines written for the Lab Master, will provide "a library of powerful real-time facilities [which will] permit the user to write programs in BASIC, FORTRAN, PASCAL, or Macro assembler using LABPAC commands as though they were part of the program itself." Included will be analog input, analog output, timing, digital input and output, and graphics. Unfortunately, this software is not currently available.

### CONCLUSIONS

Tecmar's Lab Master board provides a powerful, flexible interface for the IBM PC. At present, however, it is not supported by software. Until the LABPAC package becomes available, the Lab Master should be considered only when the requisite programming skills are available. In such situations, the Lab Master should function admirably—in fact, we have found it so valuable that we are buying another identical system. █

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**BASIC**

# Linking Assembly Subroutines to Basic Programs

**A Step-By-Step Guide To Enhance Basic**

FRED BRACK

**H**ave you ever written a BASIC program and found the command set inadequate or the execution slow? Not to worry: BASIC programs can be significantly enhanced through the use of assembly language subroutines—and this article will show you how to link the two languages.

The method discussed does not include some alternative methods, contained in Appendix C of the BASIC 1.1 (and 2.0) manual. (It is possible, for instance, to code a machine language routine right in your BASIC program in DATA statements, loading it into the BASIC workspace, and branching to it.) This article assumes that you have the IBM Macro Assembler available.

## STEP 1: ASSEMBLE AND LINK YOUR SUBROUTINE

To begin, decide what your assembly subroutine will do, and then code it. For your first subroutine, choose a simple function. Such a subroutine is included with this article.

BASIC can be linked to the subroutine by either a CALL statement or a USR function call. (This article addresses only CALLED routines.) Parameters may be passed from BASIC to the subroutine, and, within certain limitations, parameter values may be returned. Some details on coding subroutines are at the end of this article.

We would assemble the program SAMPLE with the IBM Macro Assembler as follows:

## MASM SAMPLE,,,

Assuming no assembly errors, we are ready to do the LINK. In perform-

ing the LINK, it is important to specify the /HIGH parameter. This parameter causes the loader to place the module as high as possible in memory. In a 96K or larger machine, the module will load beyond the end of the BASIC work area, thus isolating it from BASIC's span of control. With less than 96K (or DOS 2.0 and 96K), you will have to experiment with the BASIC/M parameter or CLEAR statement to isolate your subroutine.

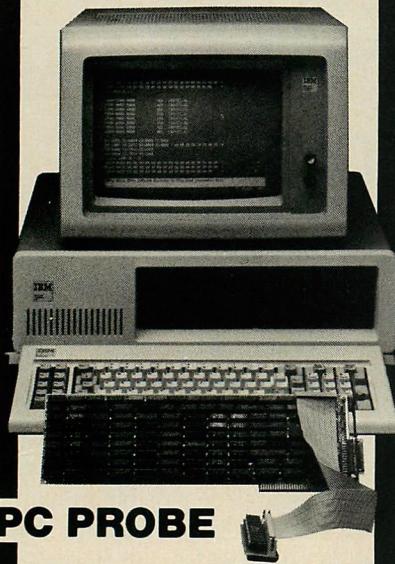
To link the object module produced by the MASM command, we could enter the following command:

## LINK SAMPLE/H,,,

*Fred Brack works in the software quality area for IBM and has been involved in data processing since 1968. He has previously published articles on BASIC in PC. This article is based on research done independently, not under the aegis of IBM.*

MARC COHEN

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## ASSEMBLY

The output of the LINK is an EXE file (SAMPLE.EXE in this case). Our objective at this point is to convert the module to a form BASIC can load directly. Since we have an EXE file, it must be processed by the DOS loader to convert it to a memory image, which can then be saved for reloading later by BASIC. The BASIC BSAVE command can save the image, and the BASIC BLOAD command can subsequently reload it. To accomplish this objective we will use the DEBUG command, which is described in the DOS manual. DEBUG can perform the necessary loader operations for us, as well as help us debug the subroutine itself. We begin

by using DEBUG to load BASIC.

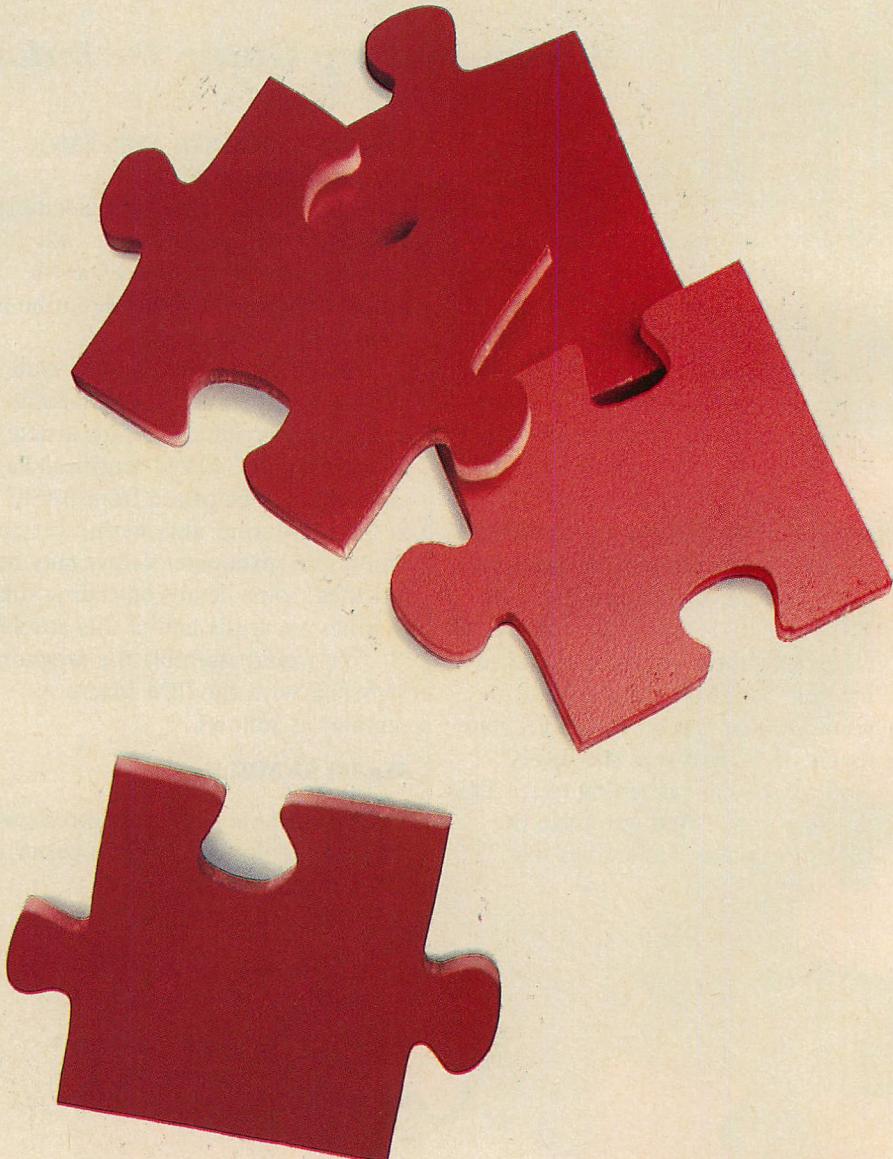
### STEP 2: LOAD BASIC WITH THE DEBUG COMMAND

To load BASIC under DEBUG, enter:

**DEBUG BASIC.COM**  
(or: **DEBUG BASICA.COM**)

The DEBUG module will load first, then it will load BASIC. You will then receive the DEBUG prompt, a hyphen (-). At this point you can enter any DEBUG command, as defined in the DOS manual.

First you need to record the register values, as you will need them later. To do so, simply type R (for registers), and press ENTER.



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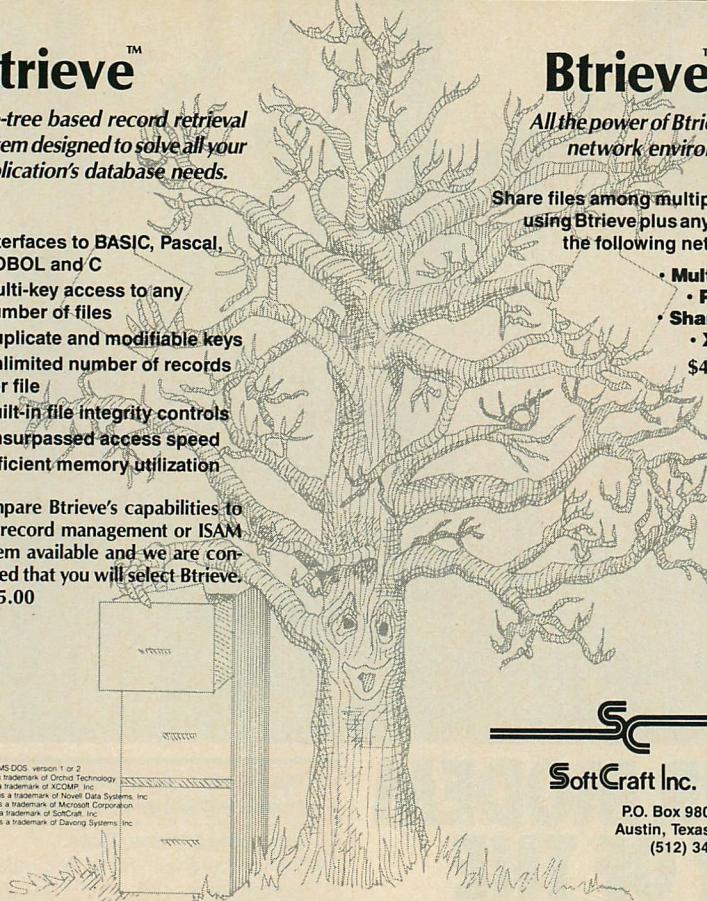
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## ASSEMBLY

—R

(The hyphen is the DEBUG prompt, already on the screen.) The values of the registers and flags will be displayed. You should log these and all following values to the printer. To do so, press Ctrl-Prt-Sc.

### STEP 3: LOAD THE SUBROUTINE WITH DEBUG

Now use DEBUG to load your subroutine—the EXE file which the LINK command created. Name the file (via the N for name, command), then load it (via L for load). Example:

—N SAMPLE EXE

—L

If necessary, the drive may be specified when naming the file (e.g., -NB: SAMPLE EXE). Because you specified /H in the LINK process, the module will load in the high end of memory, outside of the BASIC segment (assuming a memory size greater than 64K for DOS 1.1, 96K for DOS 2.0). Using the R command, display the registers:

—R

You will notice that the load address appears in the CS register, while the length of the module is in the CX register. You should record both of these values, because you will need them later. For purposes of this exercise, assume that the CS value is 1FFD, and the CX value is 21 (hex). Note that 1FFD is just a little less than 2000, which represents the segment address for 128K (the size of my PC memory), which indeed shows us that the module loaded high!

Next you should perform a step not mentioned in Appendix C: Reset the file name. When you entered the N command, the file name operand was stored in the same area of memory reserved for the operand of the command currently active (BASIC, in our case). That location is where DEBUG looks for the filename in response to the L command, and N is just a way of replacing the name (if any) that is already there. In a moment, when control is passed to BA-

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# ASSEMBLY

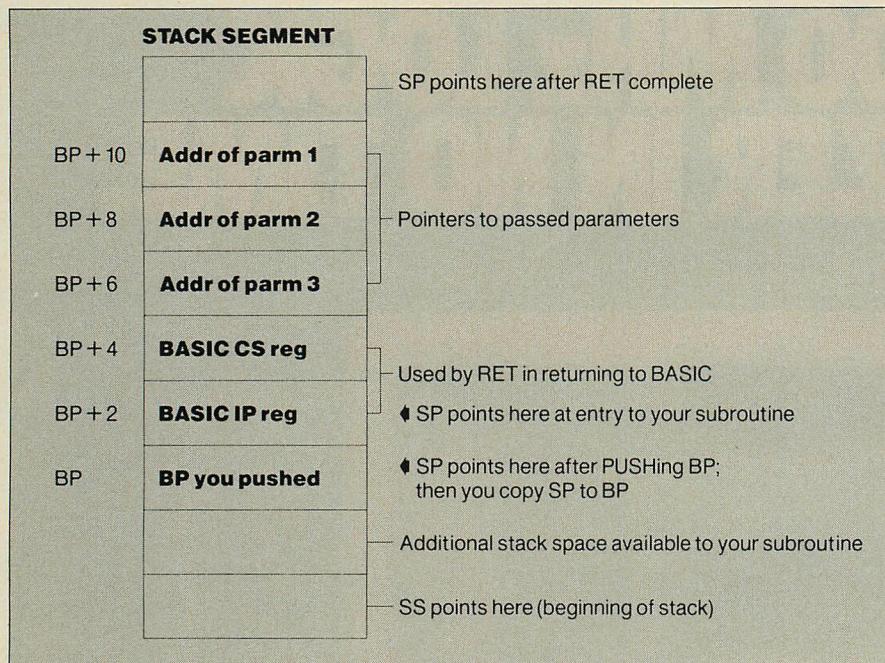


Figure 1: The Stack: Pointers and Parameters

SIC, it will see the same filename (SAMPLE.EXE), assume it is the filepec to run, try to load and run

it . . . and fail because the specified file is not a BASIC source program. You will receive the message, "Direct

statement in file." To eliminate this problem, simply enter the N command again, without an operand.

## —N

The filename field will be cleared to blanks, and BASIC will not bother trying to load the EXE file.

## STEP 4: INVOKE BASIC AND TEST THE SUBROUTINE

Now it is time to invoke BASIC. When the subroutine was loaded, the values of the registers changed. You must now change them back—which is why you recorded the initial values with the first R command.

The R command can also be used to set registers, by including the register name as an operand. You need to reset the SS, SP, CS, and IP registers. Example:

## —R IP

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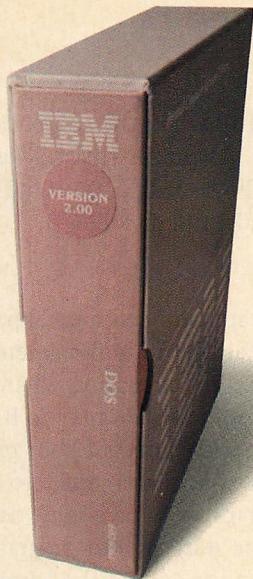
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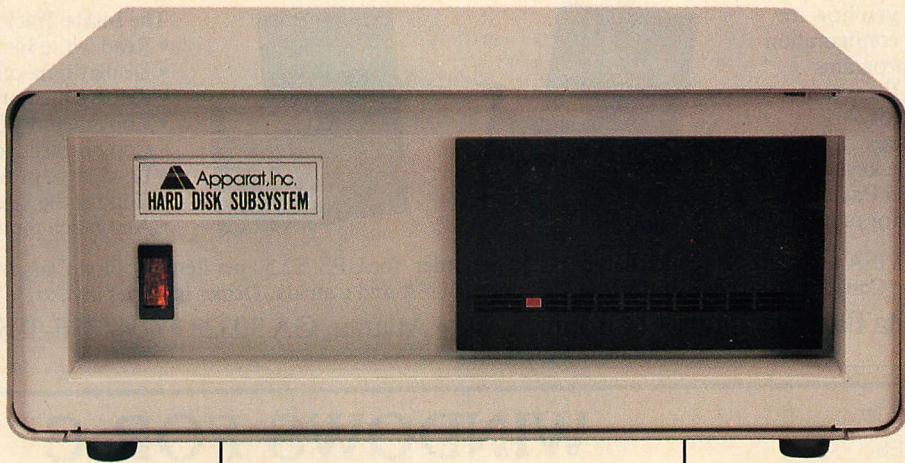
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# ASSEMBLY

:0100 <-You change value to hex  
0100

In this example, we asked DEBUG to display the contents of register IP, and the value 0000 was returned. DEBUG then gave us the opportunity to change the value. By typing 0100 (or just 100), we changed the value of the IP register. To leave the value unchanged, we would have simply pressed ENTER.

When all four registers are reset, enter BASIC by using the G (GO) command. Here, however, you must make an important decision. The G

command is also used to set breakpoints—points in the program at which execution will stop and return you to DEBUG. If you don't set (and later encounter) a breakpoint, then you cannot get back to DEBUG from BASIC, except by terminating BASIC. (In other programs you can get back by pressing Ctrl-Break; but BASIC intercepts the Break itself.)

Let's assume for the moment that you want to set a breakpoint at the entry into the subroutine. The breakpoint value is the combination of segment and offset values found in regis-

ters CS and IP when the subroutine was loaded. Assuming that CS was 1FFD and IP was 0000, you could enter the breakpoint as follows:

## G 1 FFD:0

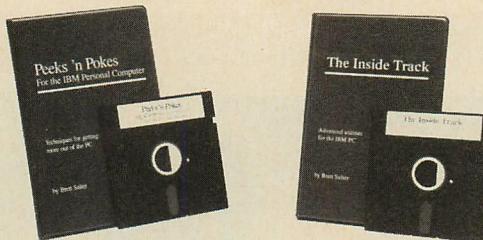
This statement sets a breakpoint at displacement zero into segment 1FFD and begins execution where it left off (in our case, at entry to BASIC). If the entry point of your program is not at displacement zero (because, perhaps, you have some data values at the start of your program), then change the zero to the correct

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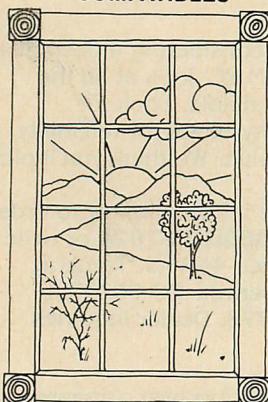
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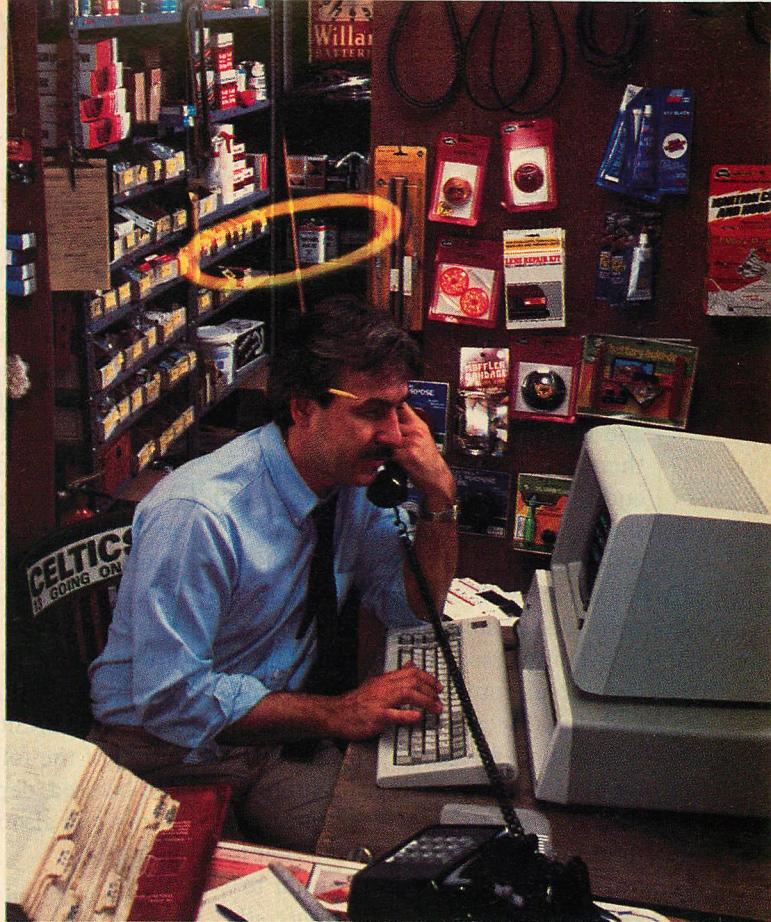
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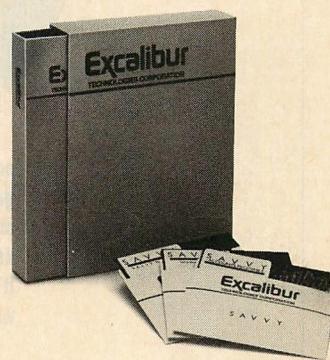
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# ASSEMBLY

offset as shown in IP.

At this point we should mention an option of the GO command that can save you a little time. An address at which to begin execution may be specified as an operand of GO, and that address effectively loads the CS and IP registers for you, then "goes" there. Since we must change both CS and IP back to their original values in the approach outlined in this article, we can use GO to do it for us, rather than reset each of them separately with the register command.

In any case, we may continue to test our subroutine until we are satisfied that it works properly. If it is unsatisfactory, we can exit BASIC and DEBUG without saving the subroutine. If it is satisfactory, we must perform one very important step that is not covered in the manual, prior to saving the subroutine: *Eliminate all the breakpoints set within the subroutine!* Failure to do so will probably cause a disaster later; you may take a

space shot—a wild branch into the middle of some routine that hangs up the whole system.

To remove the breakpoints, just execute your code again until a breakpoint is hit; then enter G without any operands. When you return to BASIC, you are ready to perform a BSAVE of the routine.

After altering registers SS and SP, we can reset CS and IP using the = operand of GO. The notation involves specifying " = ", followed by the CS value, followed by a colon (:), followed by the IP value (in other words: = CS:IP). Assuming CS and IP values for BASIC of 08EC and 0100, either of the following forms of GO can be used, depending on whether or not you also want to set a breakpoint:

**-G = 8EC:100**  
**-G = 8EC:100 1FFD:0**

If you use this approach, don't forget the equals sign! Without it, the

old values of CS and IP are used as the point at which to resume execution, and the specified values merely become another breakpoint.

Let's assume we've entered a proper GO command, and we are now in BASIC. We can LOAD a previously written program, or enter a new one. In either case, we must define our access to our newly loaded subroutine: First set the segment pointer (via DEF SEG) to the subroutine address (1FFD); then set the displacement into the segment (usually zero) using a BASIC variable (e.g., SUBR); finally, CALL the subroutine. Example:

```
DEF SEG = & H1FFD
SUBR = 0
...
CALL SUBR( ... )
```

If all goes well, when we execute the CALL statement, we will enter DEBUG mode, because we previously set a breakpoint at entry to our sub-

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routine. We may examine registers or do other DEBUG functions at this point; and, because all breakpoints are purged as soon as any one is hit, we may choose to set one or more additional breakpoints upon resuming execution. If the subroutine is short, we can step through it a line at a time by using the T (for trace) DEBUG command. This latter option is excellent for assuring that each register is loaded with the value that you expect, because registers are displayed after each statement execution.

## STEP 5: SAVE THE SUBROUTINE WITH BSAVE

The BASIC BSAVE command saves a binary image of a specified portion of memory on disk. Later, this image can be reloaded to the same or a different address in memory. The operands of BSAVE are filespec, offset, and length. The filespec can be the file name with an extension of BIN (for BINARY file). The offset should

be zero; the length comes from either the CX register when the module was loaded, the assembly listing, or the link map (they should be identical).

To tell BSAVE where the module is, perform a DEF SEG that points to the subroutine's CS value: 1FFD. Enter in direct mode:

```
DEF SEG=&H1FFD
BSAVE
"SAMPLE.BIN",0,&H21
```

The subroutine is now saved in a form that BASIC can reload later via a BLOAD statement (which must be added to your BASIC program).

## STEP 6: REACCESS THE SUBROUTINE WITH BLOAD AND CALL

The following statements can be added to your application code to access the BSAVED subroutine:

```
DEF SEG=&H1FFD
BLOAD "SAMPLE.BIN",0
```

While the second operand (the offset 0) is optional, it MUST be specified (as zero) if you later decide to load the subroutine at a location other than that from which it was saved (more on this later). To complete the call to the subroutine, again set a variable to zero (or the correct offset), and CALL the subroutine:

```
SUBR=0
...
CALL SUBR(. . .)
```

Beware: One of the most common causes of the previously mentioned space shot is failure to update the program DEF SEG value to match changes in the load point as the subroutine is subsequently modified. In other words, if you add a few statements to your assembly subroutine, the subroutine increases in size, and the load point (the register CS value) decreases by one or two. At that point you must modify the DEF SEG value already coded in your BASIC program

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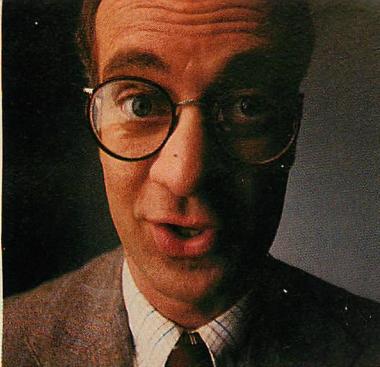
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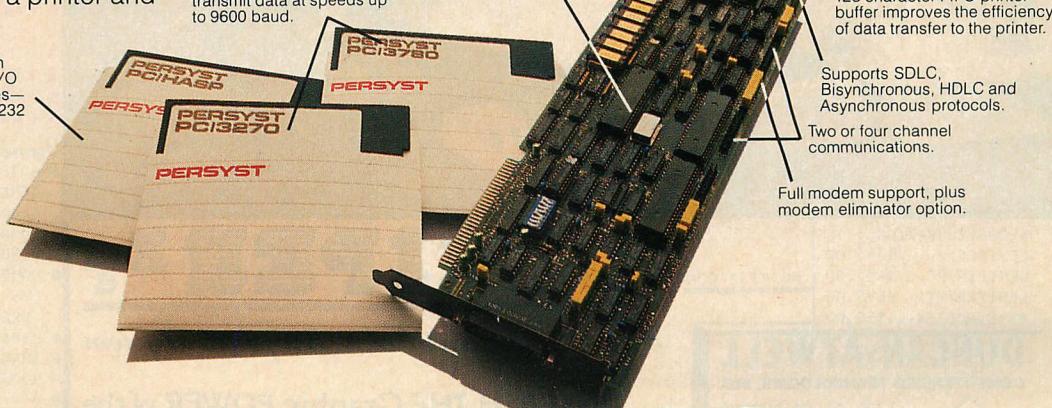
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# ASSEMBLY

to match the updated CS value.

Test your program one more time, SAVE your BASIC program, then exit BASIC with the SYSTEM command. DEBUG will return with the message "Program has terminated normally." Exit DEBUG by typing Q (for quit). Example:

```
RUN
... program output ...
Ok
SAVE "SAMPLE"
Ok
SYSTEM Program has
terminated normally
-Q
A>
```

## POINTERS FOR CODING THE ASSEMBLY SUBROUTINE

Here are some tips on writing your assembly language subroutine, particularly in the area of parameter handling. The most important restriction to note involving parameters is that

the BASIC routine must pass *exactly* the same number of parameters that the subroutine expects. A mismatch is not easy to detect. If the subroutine is expected to return values to BASIC, check Appendix C of the BASIC manual for restrictions on data-handling methods. This article assumes that INTEGER variables are passed.

A pointer to each variable in the CALL statement parameter list is PUSHed onto the stack by BASIC. (PUSH is a machine language instruction which places a value—often the address of a piece of data—into a reserved area of memory known as the stack. Items are subsequently POPped from the stack with the POP instruction.) It is up to the subroutine to locate the PUSHed addresses and access the variable data accordingly.

Appendix C recommends that the subroutine access the stacked data by loading the current stack pointer (machine register SP) into register BP (the base pointer), and then using an

offset from BP to locate each stacked word (a word is two bytes, representing the address of each variable). One key step is determining the offset from the address in BP for each parameter. Appendix C's formula makes an unexplained assumption.

The parameters are offset from BP by an amount equal to two times the number of other items that have been PUSHed onto the stack since the parameter addresses were placed there—two times, because each value takes up two bytes. When the subroutine is entered, two values have just been PUSHed onto the stack to tell BASIC where to return after the subroutine is finished. Appendix C recommends PUSHing an additional value (register BP) before accessing the parameters. Thus, three values—6 bytes—precede the addresses of the passed variables on the stack. That explains the +6 in the Appendix C formula. (Note: It is probably not necessary to PUSH BP; the Appendix



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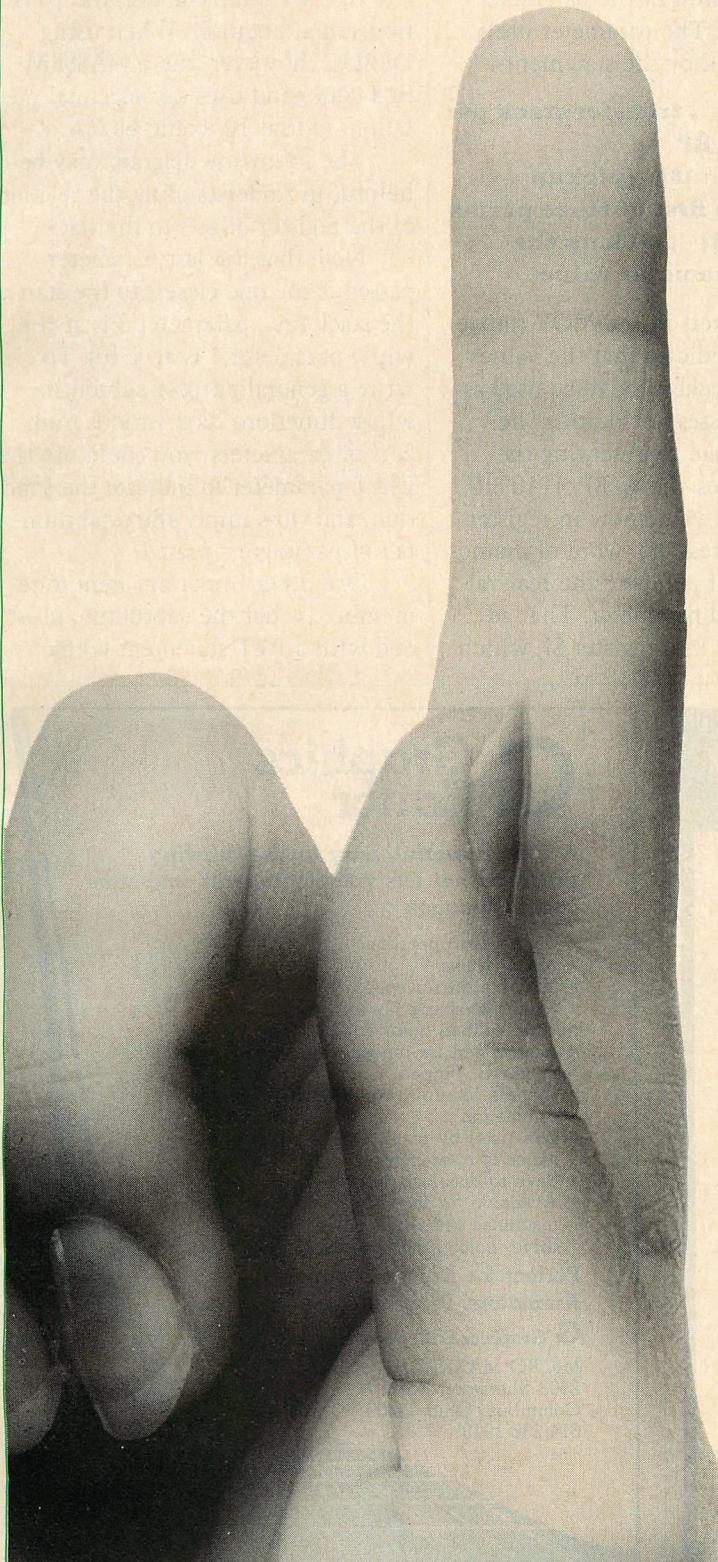


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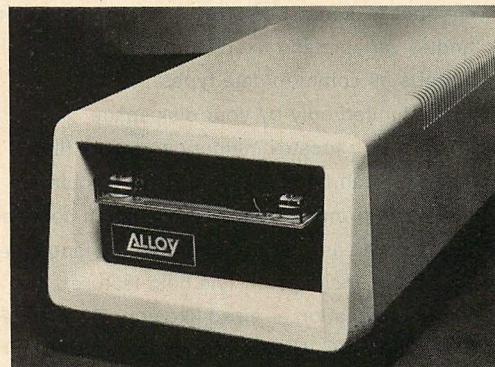
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# ASSEMBLY

is ambiguous here. You could also copy BP before PUSHing it.)

The rest of the formula calculates the offset of the particular variable you wish to access, and the formula depends on knowing exactly how many variables were passed. Since you may choose to PUSH any number of additional values onto the stack (including zero) prior to accessing the parameters, a more correct version of the formula is as follows:

**Offset from BP =**  
 $2*(n-m)+2*(u+2)$   
or  $2*(n-m)+u+4$

where:

**n** = total number of arguments passed  
**m** = number of the argument you wish to access  
**u** = number of values PUSHed by the USER so far

For example, if you PUSHed 1 register in your program, and wanted to access the first of three passed pa-

rameters, the offset would be:

$$2*(3-1)+2*(1+2)=4+6=10$$

Ten represents the increment beyond the original value of SP where the address of the parameter will be found. The parameter itself can be accessed by the statements:

```
MOV BP, SP , transfer stack ptr  
(SP) to reg BP  
MOV SI, [BP+10] , pickup  
pointer to first of three parms  
MOV AX, [SI] , pick up the  
actual parameter value
```

The brackets in the MOV (move) instructions indicate that the values within the brackets are to be used as indirect addresses for locating the data, rather than representing the data themselves. Thus,  $BP + 10$  (10 more than the value now in register BP) is the address of a word of memory which itself points to the real value of the third parameter. That address is loaded into register SI, which

in turn is used as an indirect address to cause the actual parameter value to be loaded into register AX. The last two instructions can be repeated for each of the three parameters.

In the example above, the 10 is in decimal notation. When using DEBUG, however, the UNASSEMBLE command uses hexadecimal notation, so that 10 would be OA.

The following diagram may be helpful in understanding the relation of the register offsets to the stack.

Note that the last parameter passed is the one closest to the start of the stack (i.e., parameter 3 is at +6, while parameter 1 is at +10). To write a general-purpose subroutine whose functions took various numbers of parameters, you could use the LSAT parameter to indicate the function, and thus imply the total number of parameters passed.

One other important item to remember is that the subroutine must end with a RET statement whose

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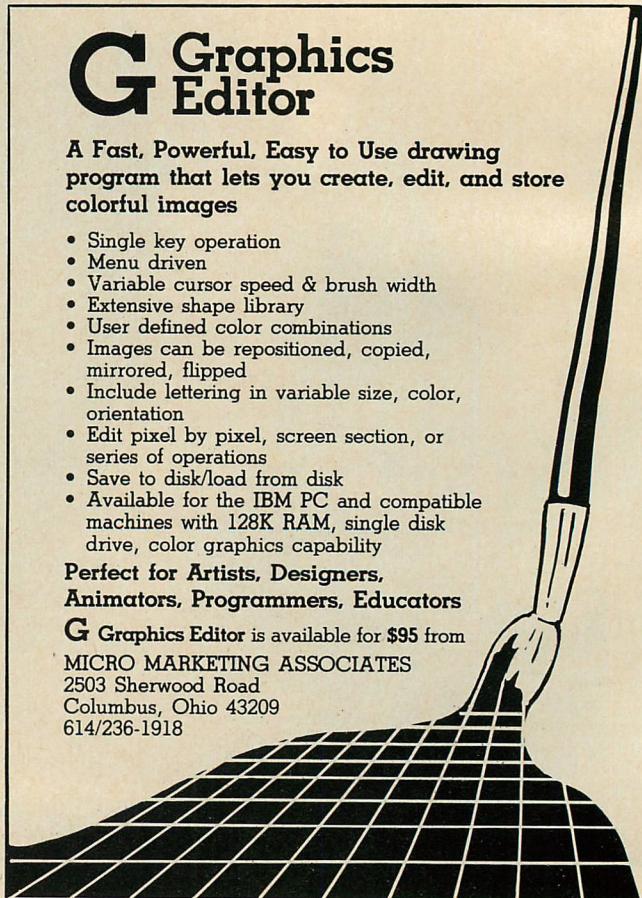
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# ASSEMBLY

operand is two times the number of parameters passed to the subroutine. Thus, in our example, 3 operands were passed, and the RET operand is 6:

**RET 6=,Return to BASIC,  
purging parameter  
pointers**

Operationally, 6 bytes will be purged from the stack.

## ACCESSING MULTIPLE SUBROUTINES

Since the load address of an EXE file can only be specified as high or low (the default) by the user, multiple BLOADs of files saved as described in this article would overlay each other. To avoid this problem, link subroutines and load them as a single file, or, BLOAD previously BSAVED files to a location other than where they were originally loaded.

When linking several subroutines together, the entry points for all but the first subroutine function will be non-zero, and will represent the offset into the EXE module where each individual routine begins. BASIC variables should be set to those offset values. Example:

```
DEF SEG=&H1FF0
BLOAD "BIGSUB.BIN"
SUB1=0
SUB2=&H1A
SUB3=&H30
...
CALL
SUB 2 (PARM 1, PARM 2. . .)
```

An alternative would be to BLOAD the various subroutines separately, by changing the DEF SEG value prior to each BLOAD. In this case, it is imperative that you specify an offset value in each BLOAD (usually 0), and that the subroutine be self-relocating. Most single segment assembly subroutines will be self relocating, but a complete description of self relocation is beyond the scope of this article. One check is to make sure that there are no R's after the generated code in your assembly LST file.

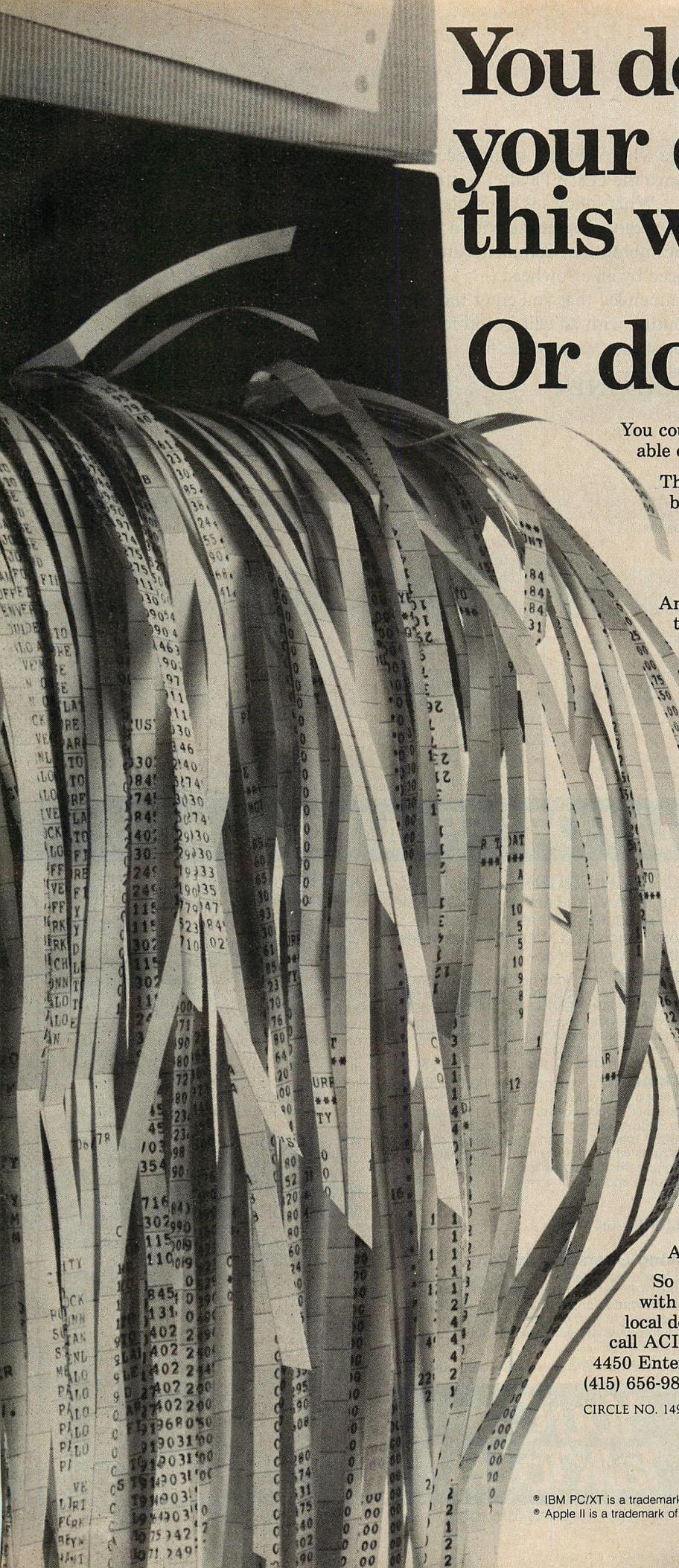
Making a subroutine and its load process independent of memory size is a real challenge. Many programmers avoid this problem by recreating their assembly code in BASIC DATA statements, reading it in, and inserting it in a BASIC string variable. This approach is discussed in Appendix C of the BASIC manual and in numerous magazine articles.

## AN EXAMPLE

To exemplify this process, we will use an assembler routine which clears a window of a certain number of lines on the screen. The routine could easily be expanded to clear a window shorter than a full line width. That code is not included.

The subroutine uses the BIOS video I/O interrupt routine, described on page A-43 of the July 1982 edition of the *IBM PC Technical Reference* manual. (The page number may be different for other editions.) We will be using function 6: Scroll Up. We will scroll all of the lines within the window defined by the user all the way (i.e., blank out the window). Note that the two parameter addresses are found at displacements 6 and 8 from the BP register (after SP is copied into BP). You can verify these displacements with the formula shown earlier. After each value is loaded into a register, it is decremented by one, since the BIOS routine calls the first line zero, the second line one, etc. Error checking of the values is not performed. The subroutine has no stack segment. Most subroutines can use the stack pointer that BASIC passes. If a stack segment is included, some modifications to this procedure will be needed.

In our BASIC program, we will need to CALL this routine with the following two parameters: first line number to clear, and last line number to clear. To clear the entire screen, for example, we would pass the parameters 1,25, and the result would be identical to the CLS statement. We would most likely use this routine, however, to clear a part of



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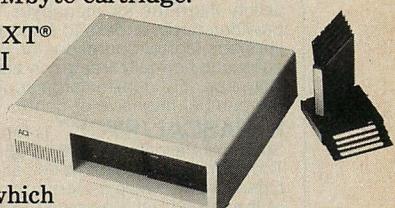
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# ASSEMBLY

the screen, keeping some lines unchanged (such as a title and perhaps a function key line, using the parameters 2,24). Note that a LOCATE,,1 statement has been added just ahead of the CALL statement. Normally BASIC runs a program with the cursor turned off. Unless this statement is included, the cursor will not be vis-

ible when DEBUG is entered. Remove the LOCATE after testing.

What follows is a complete sample session, beginning with a TYPE of the subroutine. Comments are prefaced by an arrowhead (→). It is recommended that you enter the sample routine with an editor, and follow the session exactly the first time, to

make sure you understand the procedure. If everything works well, then practice with DEBUG, and/or change the assembler module to perform additional functions (such as clearing a window less than 80 characters wide). GOOD LUCK!

## LISTING 1 LINKING SUBROUTINES TO BASIC

### SAMPLE LINKING SESSION

```
--> NOTE: Begin your session by pressing Ctrl-PrtSc,
--> to log all screen activity to the printer.
A>type sample.asm
PAGE ,132
TITLE SAMPLE - SUBROUTINE TO CLEAR A WINDOW FOR BASIC
CSEG
SEGMENT PARA PUBLIC 'CODE'
ASSUME CS:CSEG
SAMPLE PROC FAR
PUSH BP      ;SAVE REGISTER BP
MOV BP,SP    ;POINT TO STACK AREA
MOV SI,[BP+8] ;POINT TO FIRST PARM
MOV CH,[SI]   ;GET PARM (STARTING ROW)
DEC CH       ;DECREMENT IT BY 1
MOV SI,[BP+6] ;POINT TO SECOND PARM
MOV DH,[SI]   ;GET PARM (ENDING ROW)
DEC DH       ;DECREMENT IT BY 1
MOV CL,0     ;START AT COLUMN 1
MOV DL,79    ;CLEAR THRU COL 80
MOV BH,7     ;ATTRIBUTE BYTE TO USE
MOV AH,6     ;INDICATE SCROLL UP
```

```
MOV AL,0      ;SCROLL ALL LINES
INT 16        ;VIDEO INTERRUPT (TYPE IN AH)
POP BP        ;RESTORE BP
RET 4         ;RETURN, POPPING 4 BYTES FROM STACK
SAMPLE ENDP
CSEG ENDS
END SAMPLE
A>asm sample...
The IBM Personal Computer MACRO Assembler
Version 1.00 (C)Copyright IBM Corp 1981
Warning Severe
Errors Errors
0 0
A>link sample/h...
IBM Personal Computer Linker
Version 1.10 (C)Copyright IBM Corp 1982
Warning: No STACK segment      -- This is OK -- you don't need one
There was 1 error detected.
A>type sample.lst
--> output not shown <-->
A>type sample.map
Loading High      --> NOTE: Be sure this statement appears!
Warning: No STACK segment
Start Stop Length Name Class
00000H 00020H 0021H CSEG CODE
```

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# ASSEMBLY

```

A>debug basic.com
-r
AX=0000 BX=0000 CX=2C80 DX=0000 SP=FFFF BP=0000 SI=0000 DI=0000
DS=08EC ES=08EC SS=08EC CS=08EC IP=0100 NV UP DI PL NZ NA PO NC
08EC:0100 E9032A JMP 2806
--> NOTE: Some of the values shown may be different for you
-n sample.asm
-1
-r
AX=0000 BX=0000 CX=0021 DX=0000 SP=0000 BP=0000 SI=0000 DI=0000
DS=08EC ES=08EC SS=1FFD CS=1FFD IP=0000 NV UP DI PL NZ NA PO NC
1FFD:0000 55 PUSH BP
-r ss
SS 1FFD
:08ec      --> Use the values shown in the
-r sp
SP 0000
:ffff      --> first "register" display
-n
-g =8ec:100 1ffd:0
The IBM Personal Computer Basic
Version D1.10 Copyright IBM Corp. 1981, 1982
61371 Bytes free
Ok
auto      --> Begin auto line numbering and enter sample program
10 REM SAMPLE -- Test SAMPLE subroutine
20 CLS: KEY OFF: DEFINT A-Z
30 MSG$="This is a test line... This is a test line ..."
40 DEF SEG=&H1FFD
50 'hold this line for the BLOAD later
60 FOR ROW=1 TO 22
70 PRINT ROW,MSG$
80 NEXT
90 ROW1=3
100 ROW2=20
110 SAMPLE=0
120 LOCATE ,1 'Use only while DEBUGing -- delete later
130 CALL SAMPLE(ROW1,ROW2) 'Clear rows 3-20
140      --> Break to end auto entry

```

```

Ok
save "sample"      --> SAVE it now, in case you crash!
Ok
run
--> The screen should fill with the test line message
--> Then DEBUG should be entered because of the breakpoint set
AX=50E9 BX=0F3F CX=4F52 DX=0F71 SP=FFF2 BP=0F7D SI=5D07 DI=0F3E
DS=0B60 ES=0B60 SS=0B60 CS=1FFD IP=0000 NV UP EI PL ZR NA PE NC
1FFD:0000 55 PUSH BP
--> NOTE: Some of the register values may be different for you.
--> At this point you can use the DEBUG "u" command to unassemble
--> your subroutine, and/or set an additional breakpoint with "g".
--> It is recommended that you step through the subroutine by
--> using the "trace" command repeatedly. Simply type "t" over
--> and over until you arrive at the INT instruction.
--> As each instruction is traced, you can see the register values
--> change, and verify that you have accessed the passed parameters
--> properly. When you reach the "INT 10" instruction, enter "g"
--> (without a breakpoint specified). At this point you should
--> see the specified window blank out on the screen. If
--> everything works properly, you are ready to BSAVE the routine.
--> The BASIC "Ok" will probably overlay the last line of DEBUG
--> output. Before you execute the following statements, verify
--> that you left DEBUG without leaving a breakpoint set...
def seg=&h1ffd
Ok
bsave "sample.bin",0,&h21
Ok
50 bload "sample.bin",0      --> Add this line to the program
run
--> screen should fill with test lines, then clear window
Ok
save "sample"
Ok
system      --> Exit BASIC
Program terminated normally
-q      --> Exit DEBUG
A>
*** --> End of Example <-- ***

```

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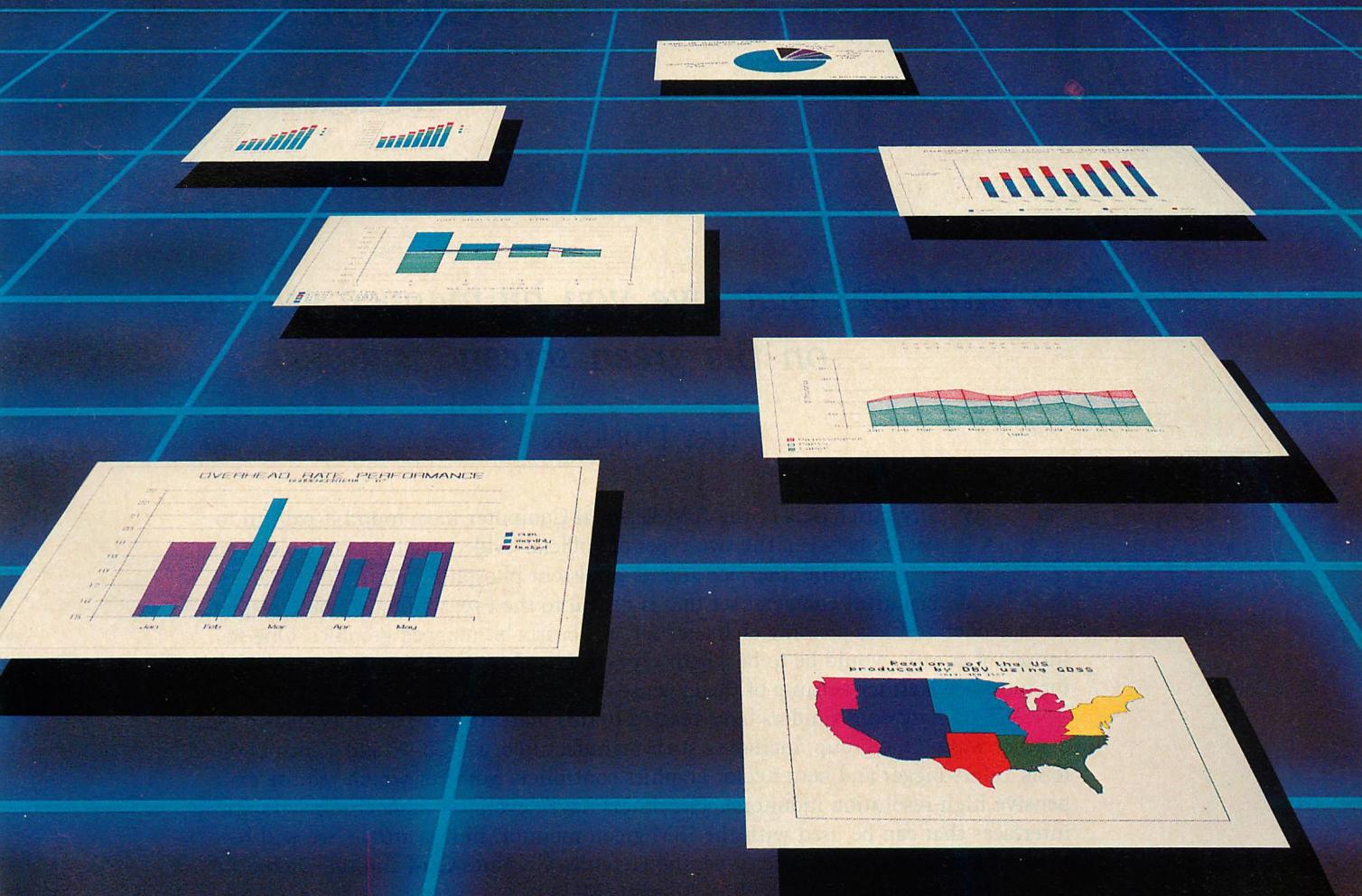


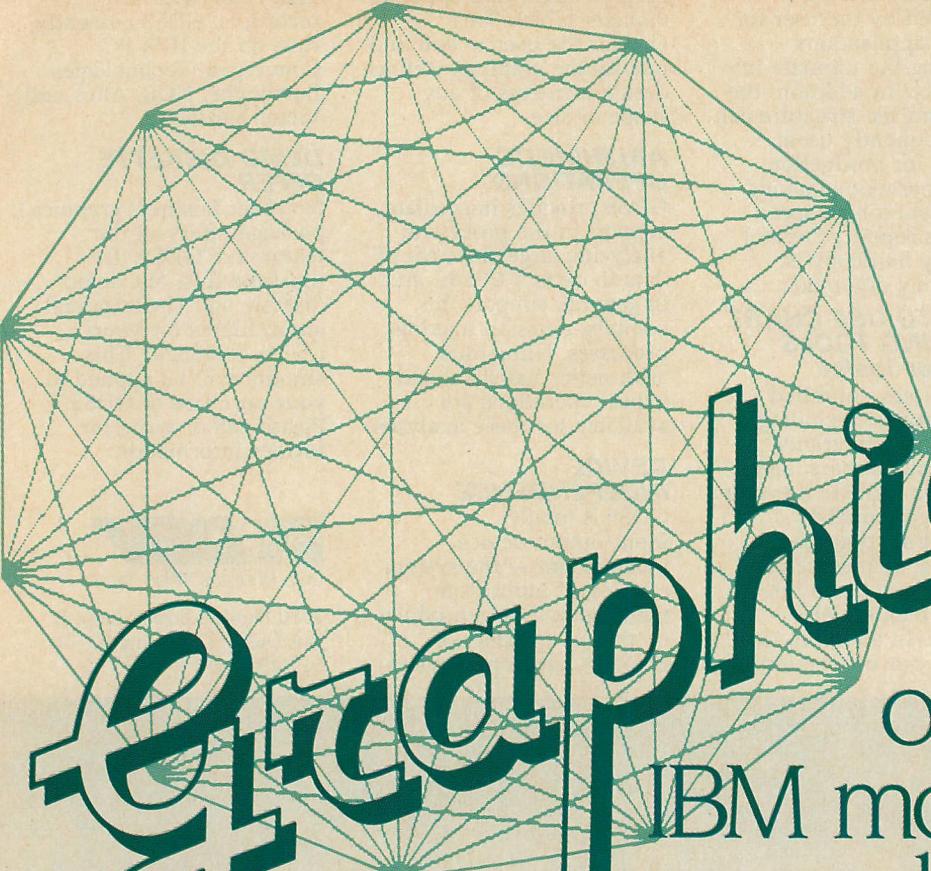
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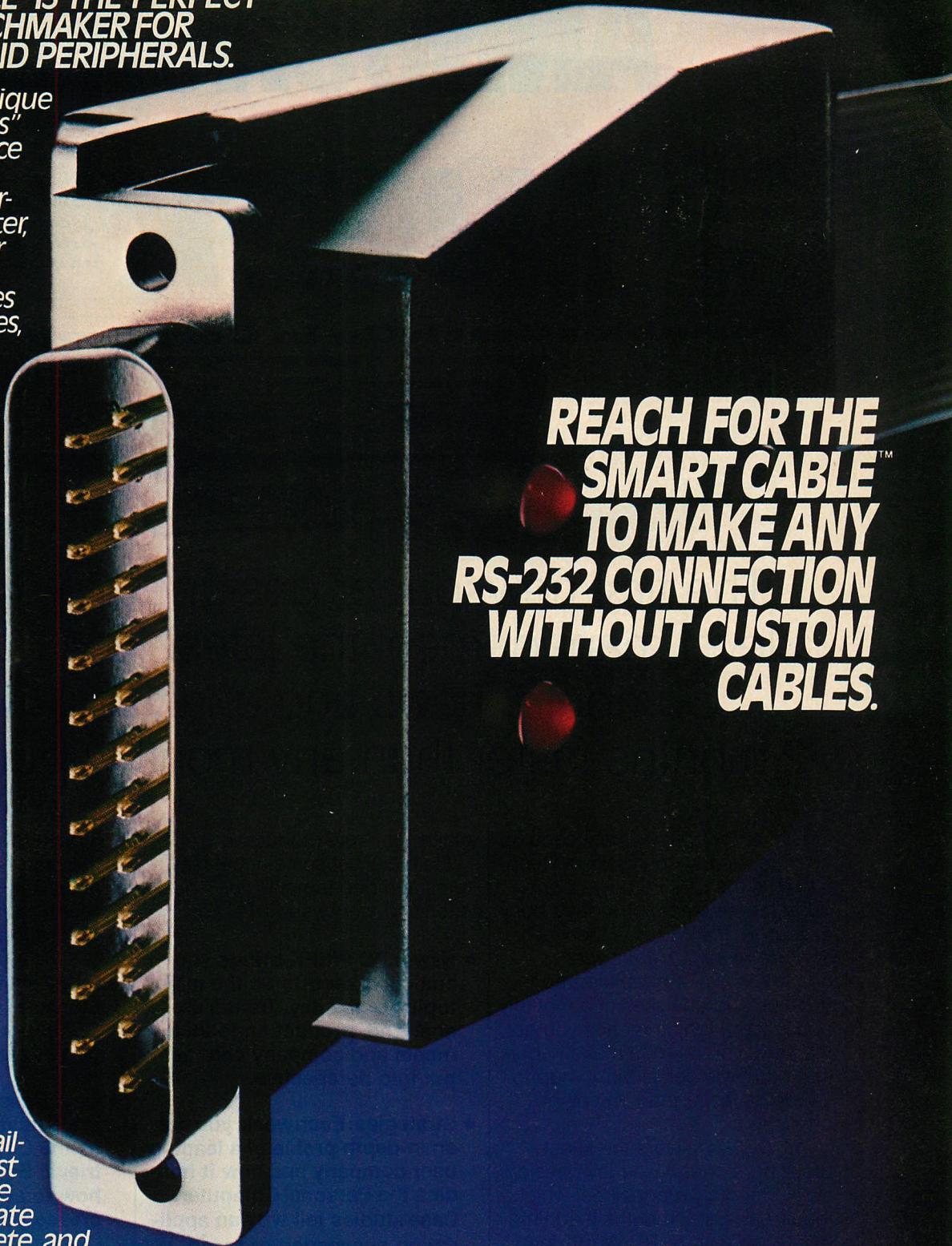
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## HARDWARE CAPABILITIES

The Hercules Graphics Card offers 720h × 384v high resolution graphics on the IBM monochrome display and also includes a parallel printer adapter. It completely replaces the IBM Monochrome Display/Printer Adapter board, using the same controller chip (6845), hardware port addresses, and status flags. The Hercules board incorporates 64K of RAM, providing two graphics pages in high-resolution mode. In text mode, the character set is the same as IBM's (7 × 9 in a 9 × 14 matrix), and the reverse video, blank, highlight, and underline attributes are fully supported. In graphics mode, text is displayed by fetching bit patterns from a table, as with the IBM Color Adapter.

Similarly, the Orchid MGA has 64K of on-board RAM and displays graphics with 720h × 350v resolution in two pages. It does not replace the IBM Monochrome Display/Printer Adapter; rather, it piggybacks alongside, taking up an additional expansion slot and connecting to the IBM board with a jumper cable. Text and graphics may be simultaneously and independently displayed.

## SYSTEM REQUIREMENTS

The Hercules board is compatible with both the IBM PC and the PC/XT. The company recommends that you do not attempt to use the

**T**here is no provision for changing the address of the memory block occupied by the Hercules board.

board with "PC compatibles" and has not tested it with any such machines. A minimum 64K of RAM is needed for the support software.

The Orchid Technology MGA requires an IBM PC with 64K of RAM. The company stated that the interface has not been tested with the PC/XT or any compatibles.

## CONSTRUCTION

The Hercules interface is built on a standard 13 1/4" silkscreened printed circuit board; it spans the full depth of the IBM PC's cabinet and will not mount in a so-called short slot of an XT. All components including memory chips and the 6845 video controller are wave soldered to the board, ex-

cept for a 2732 EPROM on a socket that holds bit tables for the character sets. The on-board memory does not have parity checking. There is no provision for changing the address of the memory block occupied by the Hercules board.

The Orchid MGA board is also of the "long" variety. It is somewhat

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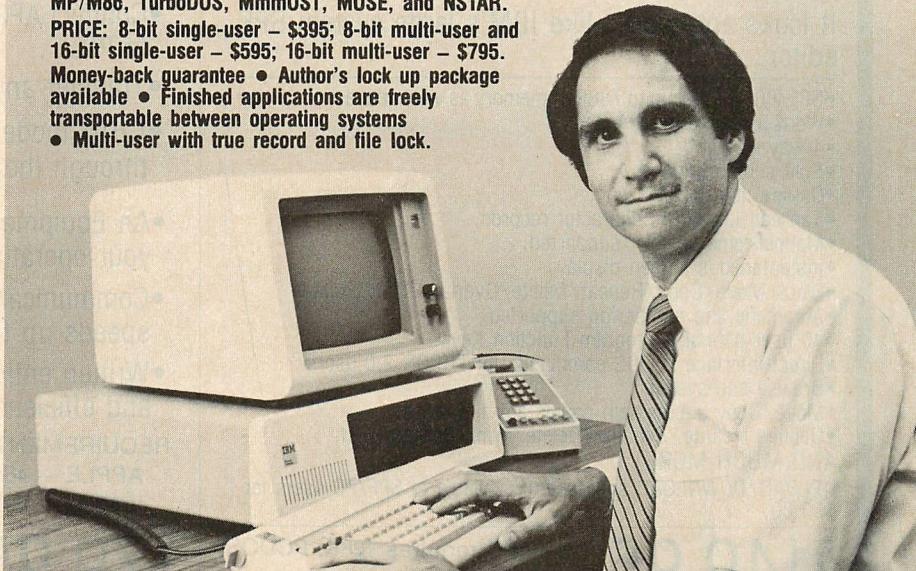
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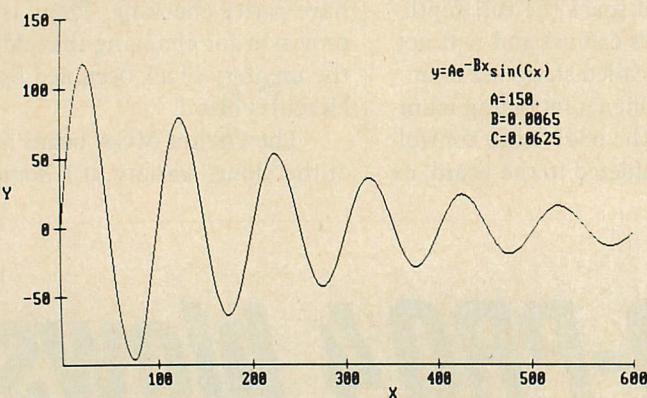
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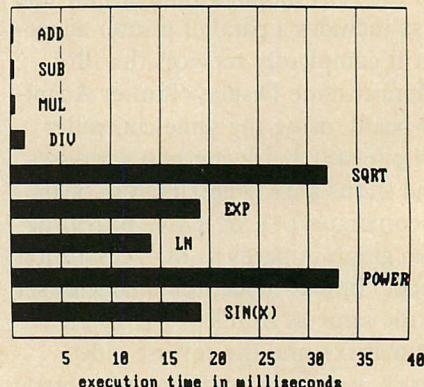
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The Hercules Graphics Card is also ideally suited for displaying high resolution plots and graphs.



...Here is the other graphics page

#### IBM Pascal Timings



less complex electronically, because it takes advantage of the controller chip present on the IBM Monochrome board. The memory chips are on sockets for easy replacement, but again, there is no provision for parity checking. The 64K memory segment occupied by the board's RAM is selected by DIP switches, and may be

relocated for the user's convenience.

#### INSTALLATION

Installing the Hercules card is simple. Open the PC unit and remove the IBM Monochrome Adapter and/or the IBM Color/Graphics Adapter (the Hercules interface occupies the memory space allocated to both the IBM

boards). Plug in the Hercules interface, securing it to the frame with a screw in the usual fashion, and connect the Monochrome Monitor and parallel printer cables to the connectors on the back. Set the System Board sense switches, as described in the IBM manuals, for a monochrome interface only. Put the PC's cover back

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metric constants, and string constants. You may choose to list any combination of these. After initializing, the program asks you for the name of the file you want to work on. Then it analyzes the text, printing out the number of the line being processed as it goes. The sorting is

done with the Quicksort algorithm. The printout shows the objects you requested, along with the line numbers on which they occur.

### **SUMMARY**

programming the IBM PC in BASIC. This article has given you the tools for exploring the interpreter further on your own if you choose. This implementation of BASIC serves its users well. Now that you understand how it works on the side, it can serve you even better.

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# PC GRAPHICS

on and fire it up—no changes to the system software are needed to use the Hercules board in normal text mode.

Hooking up the Orchid Technology board is a little more complicated. The switches on the MGA must be set so that its RAM occupies a 64K block of unused addresses; it is then plugged into a slot adjacent to the IBM Monochrome Adapter. Cables from the Orchid card pass from the back panel to both the IBM card and the IBM green monitor. In addition, a small jumper goes from a pin on the MGA to a clip, which must be pushed onto an integrated circuit on the IBM monochrome interface inside the system unit. Unlike the Hercules, the Orchid board can be used in a PC with either or both of the standard IBM Monochrome and Color adapters installed.

## DOCUMENTATION

The Orchid board came with a three

page leaflet describing installation and a 76-page, 8½"-by-11", poorly printed and photocopied manual titled *Draft*. The documentation is devoted completely to the graphics software called "HALO" supplied with the interface, and aside from legibility problems is fairly well organized and readable. The manual I received didn't contain the smallest morsel of technical information about the design of the board itself, the layout of the video refresh buffer, the control parts, or anything else that would be needed by a programmer who didn't want to use the supplied subroutines. However, a member of Orchid's technical support department stated over the phone that this material has been added.

The Hercules product didn't fare any better in this department. It came with a pair of advertising flyers that were apparently supposed to suffice as a description of its capabilities,

a three-page leaflet on converting the diagnostic diskette and loading the Herculean version of BASIC, a 16-page printed 5½"-by-8" booklet titled "Operation Manual," to be inserted in your IBM binder, and a copy of the four-page *Getting Graphic!*, the Hercules newsletter. The quality and intelligibility of these various publications vary wildly. My copy of the "Operation Manual" was missing 4 out of the 16 pages, but at least it provided a modicum of technical information for programming the board, including a description of the memory map and the controller port assignments.

It never ceases to astonish me how ambitious, high-tech startup companies like Hercules and Orchid Technology, with obviously talented personnel, can manufacture such polished, shiny, elegant hardware and be content to send out documentation that is almost laughably crude. For

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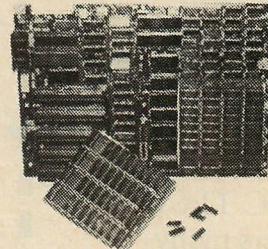
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## PC GRAPHICS

the price of four of their graphics interfaces they could at least buy themselves a letter-quality printer.

### SOFTWARE

The Hercules interface comes with HBASIC.EXE, which is mainly a graphics subroutine library occupying about 7000 bytes. It must be run from a disk that also contains IBM'S BASICA.COM. When you execute HBASIC, it loads BASICA into memory, inserts some patches, and then transfers control. From then on, BASIC may be used as though it is running the high-resolution graphics mode on the IBM Monitor, although the coordinate ranges are larger, of course. Figures you previously programmed using the IBM adapter will look distorted on the Hercules because of the different aspect ratio, and will have to be recreated with different proportions.

Although Hercules advertisements make conspicuous mention of two display pages, this capability was not available from HBASIC. The version I received did not support a medium-resolution graphics mode and was not compatible with DOS 2.0 and its expanded BASIC interpreter, or with any version of the Microsoft BASIC Compiler. A DOS 2.0 revision of HBASIC became available as I finished this piece; Hercules was charging \$10 for the update.

For programmers wishing to use assembly language or high-level languages other than BASIC, Hercules offers an assembly language subroutine library called Graph X for \$50. The library supports point plotting, line drawing, circles, arcs, convex polygon-fill, paging, and mode select. A graphics screen dump is also included. Hercules's stated policy is that programmers may not redistribute the graphics routines embedded in their applications without paying a royalty, so the popularity of this package will probably be limited.

The newsletter *Getting Graphic!* mentioned a number of external software packages supporting the Her-

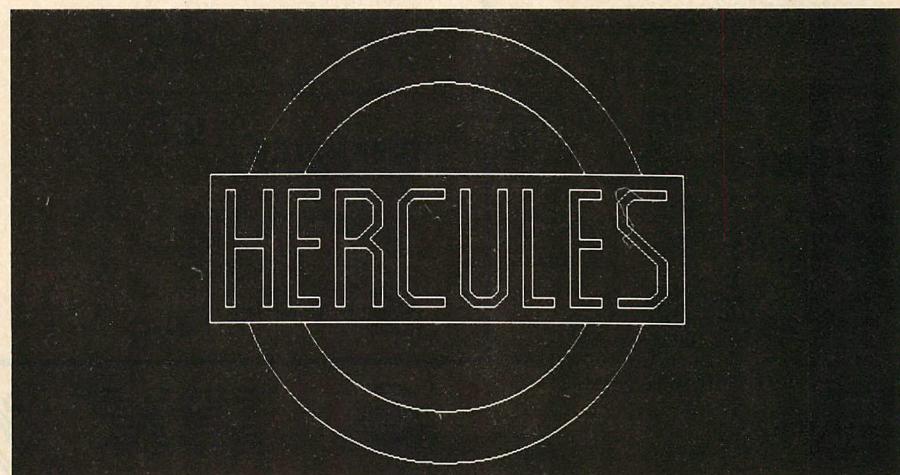
# PC GRAPHICS

cules graphics card. The most significant appeared to be Lotus 1-2-3; but the list also included a version of UCSD Pascal with Turtle Graphics, two Computer Aided Design programs, and Tektronix 4010 Emulators.

Software support for the Orchid Technology product is considerably stronger and is based on the HALO graphics package, an amalgam of many of the functions available in the SIGGRAPH CORE, the European Graphics Kernel System (GKS), and Digital Research's GSX. Functions provided include setting and reading the location of various types of cursors, point plotting, setting line style, setting marker and polymarker, drawing single or poly-lines both relative and absolute, boxes, arcs, circles, ellipses, area fill, and tiling with user-specified patterns. A graphics screen dump to printer is present. Animation capability is provided by MOVE-FROM and MOVETO verbs, which are the equivalent of BASIC's GET and PUT. Commands to read and write compressed graphics images to a diskette are also provided, but, strangely, operate on absolute track and sector addresses and are not compatible with the PC-DOS file structure.

HALO is distributed as a set of machine language subroutines that can be loaded into high memory and called from any language including all versions of IBM BASIC. Linkable libraries for use with the Macro Assembler, IBM's BASIC, Pascal, and FORTRAN compilers, IBM's APL interpreter, and the Lattice C compiler are also available. A nifty interactive program called LEARNHALO was included with the board. It contains a high-level command processor that allows you to invoke each of the HALO functions by name, draw complex figures, and experiment with different parameters.

The version of GSX included with Digital Research's new \$60 CP/M-86 package includes graphics drivers for the Orchid board only. However, Digital is in the process of



developing the driver for the Hercules board on GSX for the PC.

## SUBJECTIVE CONCLUSIONS

I ran some simple benchmarks from BASIC (plotting a thousand straight lines, circles, etc.) and found the apparent graphing speed on the two boards was essentially the same.

When writing programs in BASIC,

the time spent in the BASIC interpreter mostly swamps out the time spent in the machine language plotting routines, so any differences in the efficiency of the code supplied by the two vendors are not very apparent. The quality of the display was excellent on both boards.

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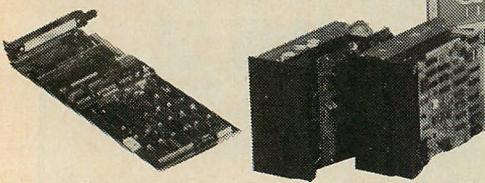
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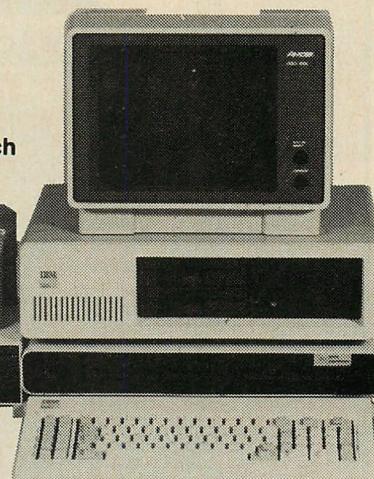
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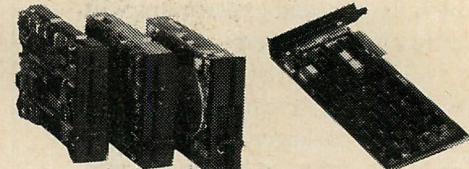
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the HALO software were clearly far superior to the Hercules software. For example, it is possible to create an arbitrarily shaped region that the Hercules PAINT command will not fill completely, but I could not get the HALO equivalent to fail at all.

The Hercules Graphics Card was certainly well built and easy to install. It performed reliably and had crisp graphics displays. However, the jury-rigged nature of the software linkage to IBM's BASIC was alarming. Each time a new revision of PC-DOS and BASIC arrives from IBM, Hercules board owners will have to fret and wait while the company's programmers figure out some new patches. The recent support of Lotus 1-2-3 for the Hercules card may make it the best selection for business environments where spreadsheets and resulting graphic renditions are the principal use.

Overall, I found the Orchid Technology product preferable, mainly because of its sophisticated software support for the Assembly language programmer and the various high-level languages other than BASIC. The LEARNHALO program and the competitive price are nice bonuses. The fact that the graphics refresh buffer is separate from the text buffer makes it convenient to independently manipulate and swap graphics and text display pages. The only consideration weighing against the Orchid board is that it occupies an extra expansion slot. Ironically, Orchid Technology, focusing all of its marketing efforts on its highly successful local network hardware, does not even mention the MGA in its advertisements. This is a shame, because from every standpoint MGA compares favorably with the Hercules Graphics Card.

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Sooner or later, everyone has occasion to need a disk copied. On a typical PC, copying both sides of a 5 1/4-inch disk takes a minute or so. For an occasional copy that will do, but what if your program catches on, and orders start pouring in?

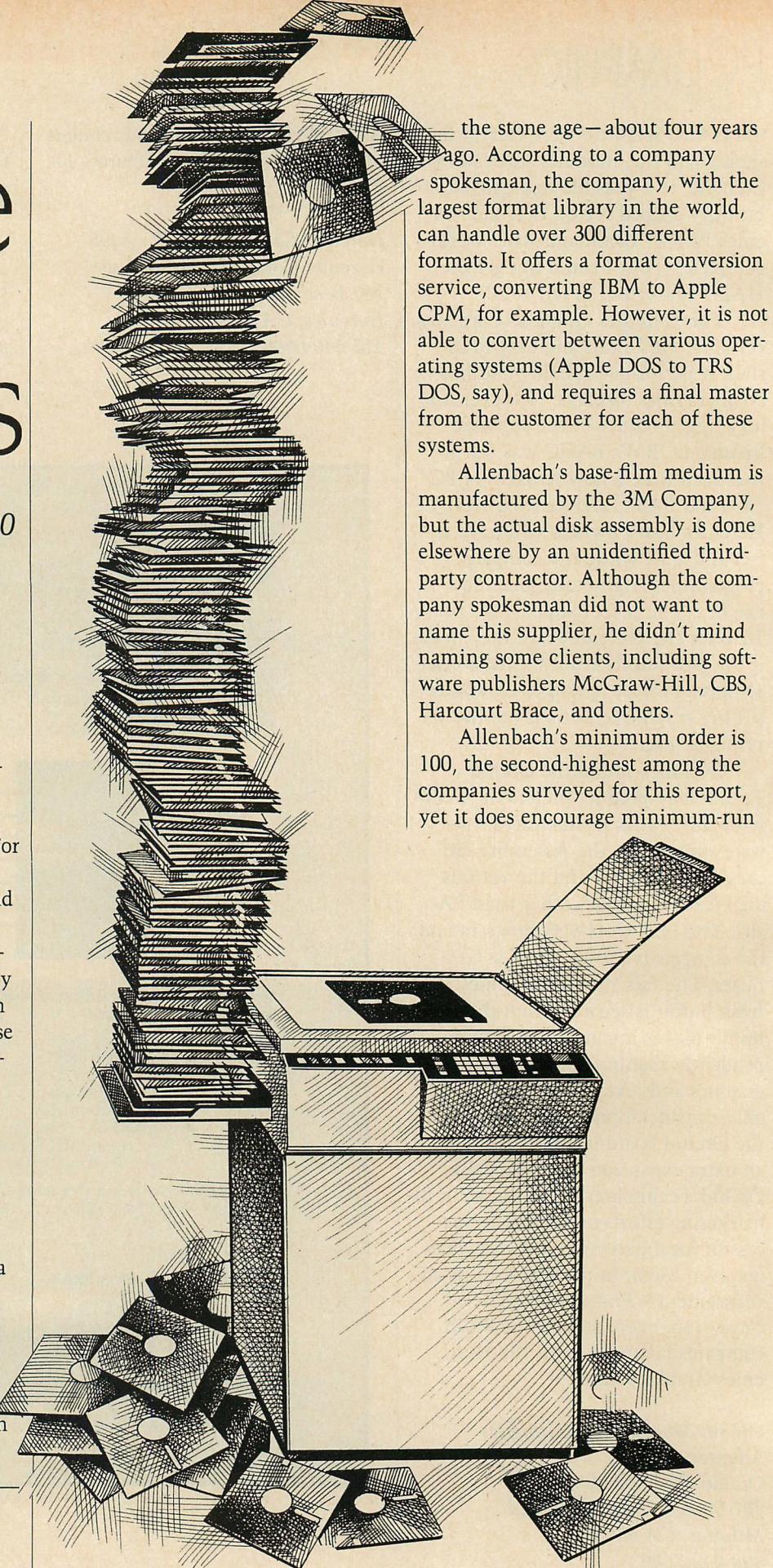
It's time then to call up disk duplication services. Some will not only copy your disk, they will also design and package your program and advise you how to get your product to market or distribute it to your corporate subdivisions nationwide or do whatever it is you want to do with 10 to 10,000 copies of your diskette.

## WHO'S OUT THERE?

Disk duplication services are springing up all over, but there are a few relatively established concerns, one of which should be able to handle your order, whether it's for 20 copies, or more.

In PC terms, Allenbach Industries began its duplication services in

*John Woram is editor of db, a sound engineering magazine, and of Modern Recording and Music. He owns a PC and is a frequent contributor to PC magazine.*



the stone age—about four years ago. According to a company spokesman, the company, with the largest format library in the world, can handle over 300 different formats. It offers a format conversion service, converting IBM to Apple CPM, for example. However, it is not able to convert between various operating systems (Apple DOS to TRS DOS, say), and requires a final master from the customer for each of these systems.

Allenbach's base-film medium is manufactured by the 3M Company, but the actual disk assembly is done elsewhere by an unidentified third-party contractor. Although the company spokesman did not want to name this supplier, he didn't mind naming some clients, including software publishers McGraw-Hill, CBS, Harcourt Brace, and others.

Allenbach's minimum order is 100, the second-highest among the companies surveyed for this report, yet it does encourage minimum-run

JOE SCROFANI



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Purchase ..... 20

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Abstat ..... \$ 349  
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d-Base Window ... \$ 159  
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### Decision Resources

Chartmaster ..... \$ 289  
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### Digital Research

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CP/M-86 ..... 39  
Cobol 86 ..... 499  
Pascal MT + 86  
CP/M 86 w/SPP ..... 375  
SPP 86 ..... 130  
C Basic 86 ..... 135  
PL/I 86 ..... 499

### Dow Jones

Market Analyzer ..... \$ 245  
Eco-Soft

Microstat ..... \$ Call

### Emerging Technologies

Edix (editor) ..... \$ 139  
Wordit (formatter) .... 139

### Graphic Software

Super Chartman II .... \$ 299  
Super Chartman IV ..... 199  
Both ..... 350

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MS Pascal Compiler ... 249

C Compiler MS/DOS .. 329

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We will cheerfully oblige.

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C. Itoh Prowriter 1550P ..... 689  
NEC 3550 ..... \$ Call  
NEC 8023A ..... \$ 475

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Microline 83A ..... \$ Call  
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Prism 80 (w/4 options) \$ 1,399

### IDS/Data Products

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### Star Micronics

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Gemini 15X ..... \$ Call

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### NEC JC-1216 RGB

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### Taxan 12" Amber

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### AST Research

ComboPlus 64K Clock/

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Expandable to 256K ... \$ 279

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# DUPLICATION

jobs. Company president Phil Kessler, who recalls the time when a large order meant 100 copies, feels he owes his business success to the small-timer. Consequently, he's set up a special department to insure that small orders are expedited without having to wait for slack time between big jobs.

If you don't have any ideas for the design of your software package, I/O Management Company offers a full line of design services. If you like, I/O will even get involved in the marketing of your program. The people at I/O use a distributor network to find out what the prospects are for placing and selling your software. They report the prospects to you, and then you decide on your course. Do you want to get the capital together and go full speed ahead? If you do, I/O also offers printing and typesetting services, and can put together display racks, and work out merchandising programs for you.

As for the diskette duplication

service itself, I/O wouldn't give technical details over the phone. The spokesman did say that the company would make two masters from your diskette, and send one of them to you

**I**f you don't have any ideas for the design of your software package, I/O Management Company offers a full line of design services, as will several other such services.

for verification. Once you gave the OK, the other one would be used for production. When pressed further, the spokesman wouldn't say much, except that I/O likes Omni diskettes, but will offer all brands on request. Copy protection, serialization, and rush services are all available, and the minimum is 50 copies.

In contrast to I/O, DisCopyLabs is strictly a duplication facility, and does not get involved with advertising or marketing on behalf of clients. Art work, custom labeling and other such services are all sub-contracted or supplied by the customer. Although reluctant to get into technical details over the phone, a company representative did say that DisCopyLabs offers extensive down-loading services, and translation between CPM, MS-DOS, and PC-DOS. At DisCopyLabs, the minimum order is 20 copies; for quantities fewer than 2000, a five-day turnaround is typical.

Even the big guns are getting into the game. A few months ago, IBM announced its entry into diskette duplication service. The press release promised track-by-track, bit-by-bit monitoring facilities, installed in a clean room to insure data integrity, freedom from process errors, and the highest-quality production.

Is IBM really interested in woo-



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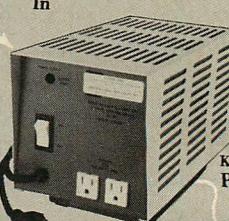
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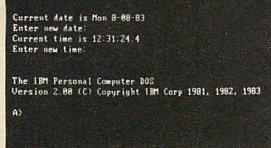
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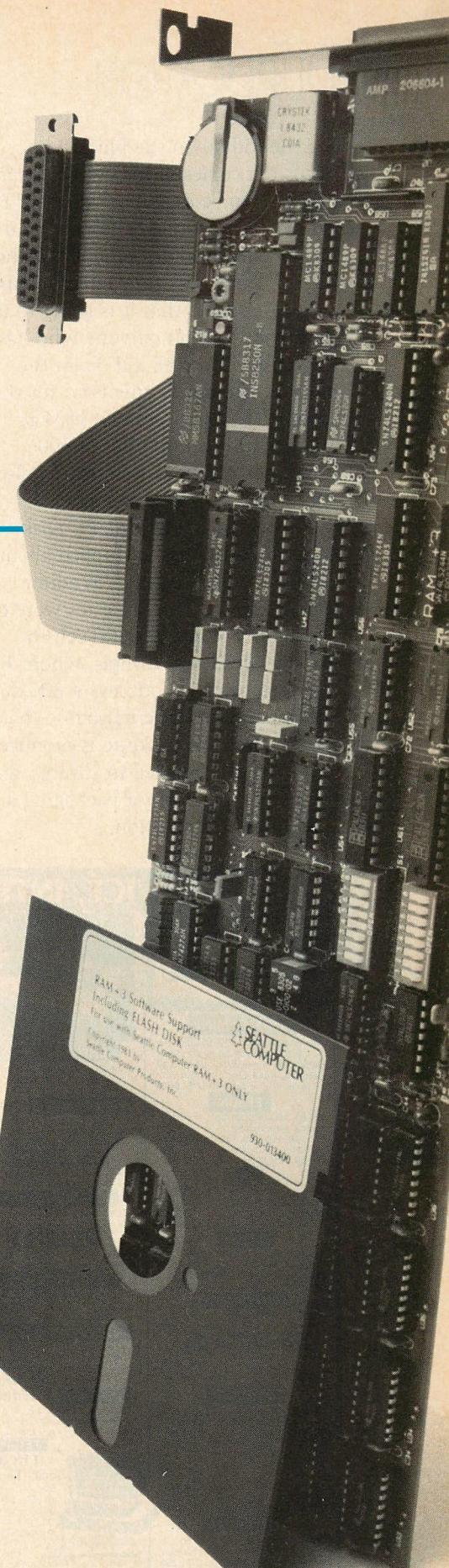
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**RAM + 3 prices start at \$210.00\***

\*(Unsocketed, no memory version;

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CIRCLE NO. 169 ON READER SERVICE CARD

# DUPLICATION

ing the kid down the block who needs ten copies of his own program, or is this to be an elite service for Fortune 500 companies who need to duplicate data diskettes reliably, without having them fall into enemy hands?

IBM claims that it is going to target a wide market: anyone who has the money, but the kid down the block is effectively ruled out for the moment anyway, because IBM requires a minimum order of 500 copies per master. For anything else, you'll have to go elsewhere.

Speaking of big jobs, *PC Disk Magazine*'s first issue shipped about 20,000 copies, according to editor Morris Effron. The diskettes were duplicated by Wabash DataTech in Rolling Meadows, Illinois, whom Effron says can turn out about 500 diskettes per hour. The magazine that accompanies the diskette is produced in New York, printed in Illinois, and shipped to Wabash for packaging and subsequent distribution.

## HOW MUCH WILL IT COST?

If you need to know how much a certain piece of hardware is going to cost, it's usually not difficult to do comparison shopping by phone. Not so with diskette duplication services. Not one of the services contacted

**N**ot one of the diskette duplication services contacted would give a straight price for a minimum order. Fair enough. There are so many variables involved that it's almost impossible to offer a quote over the phone.

would give a straight price for a minimum order. "It depends on the customer's requirements," was the almost-stock answer. Fair enough. There are so many variables involved that it's almost impossible to offer a

quote over the phone. Still, what would a minimum "no-frills" order cost? Over the phone, only IBM would say. Based on a 500-copy order, the duplication service charge is fifty cents a disk, plus diskettes, printing, and other materials.

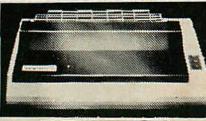
At DisCopyLabs, duplicating a single-sided 5 1/4-inch disk costs \$2.75 per copy for 20 copies, and \$2.15 each for 2500 or more copies. For double-sided disks, the corresponding prices are \$4.25 and \$3.25. There is a set-up fee of \$10.00 per master.

But how do you want those disks delivered? In plastic baggies, or in elegant shrink-wrapped containers, with 3-D, four-color artwork? Costs can vary wildly, hence the reluctance of duplicating services to quote over the phone. All of them would rather see your design ideas first, and then work up a price estimate.

Will we be seeing cheaper, faster duplication in the near future? Comparing diskette duplication facilities

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Gemini-10X, 120 CPS, 80 col., friction & tractor feed, (parallel) \$Call  
Gemini-15, above w/15" platen. Call  
Delta-10, New! Like 10-X but with a faster speed of 160 CPS \$Call

### EPSON

FX-80, 160 CPS, 80 col., friction & tractor feed, parallel \$Call  
FX-100, 160 CPS, 136 Col., friction & tractor feed, parallel \$Call  
RX-80, MX-80 F/T, MX-100... Call

### NEC

3550 Spinwriter, 30 CPS, 203 Col., letter quality, (parallel) \$Call

Tractor for NEC 3550... \$245

8023A, 100 CPS, 80 col., par. \$385

### C. ITOH

8510AP Prowriter, 120 CPS, 80 col., graphics, (parallel) \$Call

1550 Prowriter-II, 120 CPS, 136 col., 2K buffer, graphics, (parallel) \$Call

### RITEMAN

120 CPS, 9x9 matrix, trax/trac/ friction feed, compact, (parallel) \$389

### TOSHIBA P1350

Super dot-matrix printer, w/24-pin hi-resolution head, 192 CPS draft, 100 CPS letter-quality (parallel) \$Call

### OKIDATA

ML-82A, 120 CPS, 80 col., pin & friction feed, serial & parallel \$379

ML-83A, 120 CPS, 136 col., tractor & friction feed, parallel/serial \$629

ML-84P, 200 CPS, 136 col., friction & tractor feed, (parallel) \$889

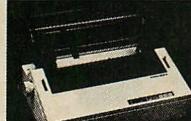
ML-92P, 160 CPS, 80 col., friction & tractor feed, (parallel) \$499

ML-93P, 160 CPS, 136 col., tractor & friction feed, (parallel) \$849

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IDS Prism 80, 200 CPS, 80 col., 4-color, graphics, friction/tractor feed, sheet feeder, (parallel) \$1,259

IDS Prism 132C, above but 132 col., parallel \$1,495



### BROTHER HR-25

New! 23 CPS daisywheel printer w/ 2 color printing, 3K buffer, proportional spacing, etc. Parallel \$769

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16 CPS daisywheel printer, bi-directional printing, proportional and incremental spacing, Parallel \$649

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40 CPS daisywheel, (parallel) \$1,089

55 CPS daisywheel, (parallel) \$1,349

### DYNAX DX-15

13 CPS daisywheel printer, 2-color printing, 3K buffer, (parallel) \$Call

### JUKI 6100

18 CPS daisywheel, 13" platen, 2K buffer, 3-pitch, (parallel) \$539

### FUJITSU SP-830

A super daisywheel printer w/ultra fast 80 CPS printing speed, plus many outstanding features \$2,095

### DAISYWRITER 2000

The intelligent letter-quality printer w/48K built-in buffer, memory, 17 CPS, bi-directional, auto margin selection, universal interfaces \$1,059

### TELETEX TTX-1040

TTX-1040, 12 CPS daisywheel with built-in tractor adjustable 2x-14".

Parallel & serial interfaces \$519

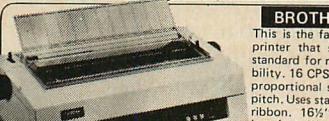
### TELETEX TTX-3000

Smart Terminal

Built-in text editor & graphics, memory, etc.

Design for upgrading to stand-alone computer, word processing & telecom system. 80x25 line swivel screen, 10 function keys & numeric keypad. \$549

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#### Multi-Function Cards for IBM PC and XT

New Low Prices!

(Each card now comes w/ SuperDrive & SuperSpool)



#### ComboPlus II Cards

Amount of memory installed on board... none 64K 128K 192K 256K with serial, parallel & clock/calendar \$225 \$265 \$315 \$365 \$415

#### SixPakPlus Cards

Six-function card with 64K-384K RAM memory, Parallel port, Serial port, Optional Game port, Clock-Calendar, SuperDrive & SuperSpool Software.

Memory installed on card... none 64K 128K 192K 256K 320K 384K with parallel, serial ports & clock \$227 \$267 \$317 \$367 \$417 \$467 \$517 above plus game port \$262 \$302 \$352 \$402 \$452 \$502 \$552

#### MegaPak Plus Cards

Amount of memory installed on board... none 64K 128K 192K 256K with serial port No. 1, 8 clock \$226 \$266 \$316 \$366 \$416

w/either parallel or serial port No. 2 \$274 \$314 \$364 \$414 \$464

w/both parallel & serial port No. 2 \$309 \$349 \$399 \$449 \$499

MegaPak - expands fully a popularly used MegaPlus card (256K) to 512K \$299

#### I/O Plus II Cards

Standard card w/one serial port (S1) and clock/calendar. \$129

Additional Parallel (P), Game (G), or Serial 2 (S2) port... add \$35 ea.

#### QUADRAM

QUADBOARD Multi-Function card for IBM PC. Full parity, clocking & memory selective addressing w/QuSool & ODrite software.

Amount of memory installed on card... none 64K 128K 192K 256K with parallel, serial ports, clock/calendar \$235 \$275 \$325 \$375 \$425

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TASCMASTER Software with AddRam Elite or AddRam Plus

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AddRam Elite (parallel & serial ports) AddRam Plus (Two serial ports) Memory installed... 64K 128K 192K 256K 320K 384K 448K 512K \$399 \$459 \$519 \$579 \$639 \$699 \$759 \$819

#### Panasonic

Panasonic half ht. DSDD 320K \$249

Panasonic half ht. DSDD 320K \$199

Panasonic half ht. DSDD 320K \$199



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BMC BM-AU9191MU, 13" RGB color, 640-dot, 16 color \$449

Prism 13" HX-12, 12" RGB color, 680-dot resolution, \$479

Amdek RGB Color II Plus, 640-dot, 16 colors \$469

Quadochrome, 12" RGB Color, 690-dot, \$569

Zenith UVM 134 RGB Color \$399

\*\*\*\*\* GREEN SCREEN \*\*\*\*\*

Dynax GM-120, 12" green, 600 line, 20 MHz, List \$200, \$129

USI PI-2, 12" green, 1,000 line, 20 MHz, \$155

Taxan KG-12N, 12" green 800-dot, List \$199, \$149

\*\*\*\*\* AMBER SCREEN \*\*\*\*\*

Amdek 310A, 12" amber, 720-dot, runs on IBM monochrome card & multi-displays cards only \$179

Dynax AM121, 12" amber, 600-dot, 20 MHz, List \$250, \$149

Taxan KA12N, 12" amber, 800-dot, List \$205.00, \$150

USI PI-3, 12" amber, 1,000-dot, 20 MHz, \$169

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The Text Manager \$250 \$179

VisiCalc/256K \$250 \$169

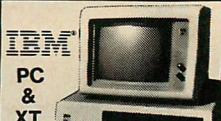
Real Estate Analyzer \$250 \$189

SuperCalc I \$295 \$125

SuperCalc II \$295 \$179

Spell Guard \$195 \$119

Super-Writer \$295 \$185



### IBM PC & XT COMPUTERS

Call for price & availability

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Friday \$199

Bottom Line Strategist \$285

Home Accountant Plus \$150 \$99

TK!Solver \$299 \$219

Multiplan \$275 \$175

PFS: File \$95

Versaform \$389 \$249

PeachPack (GL/AR/AP) \$395 \$239

Peach Text 5000 \$237

The Text Manager \$250 \$179

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Real Estate Analyzer \$250 \$189

SuperCalc I \$295 \$125

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Spell Guard \$195 \$119

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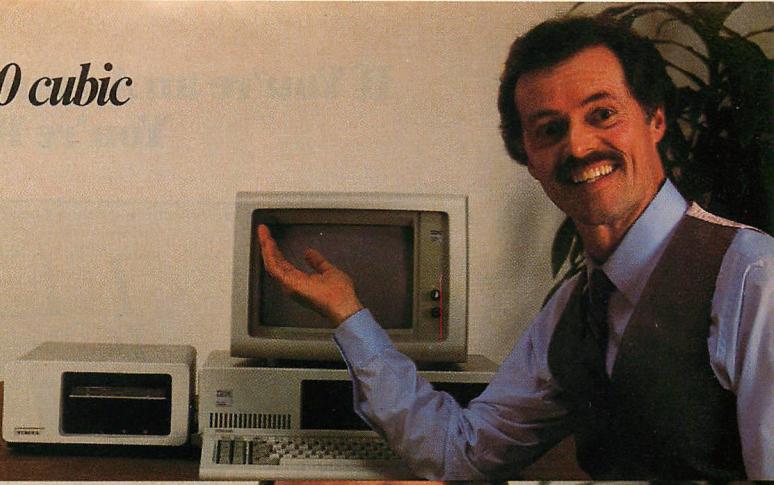
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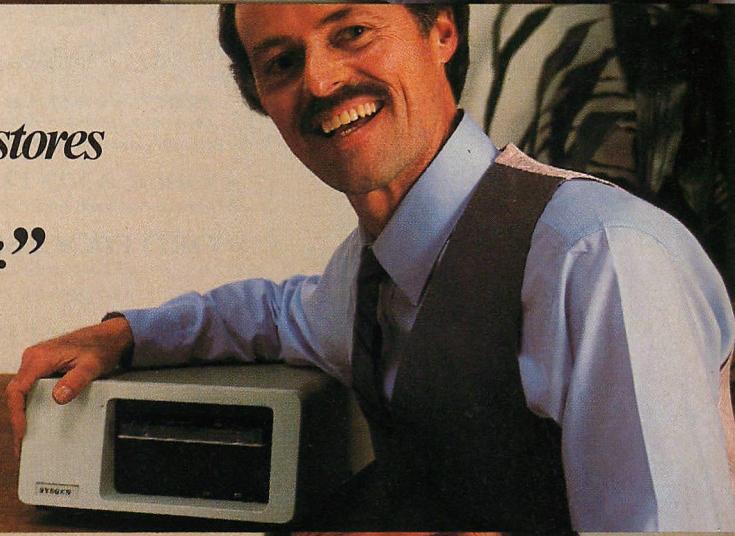
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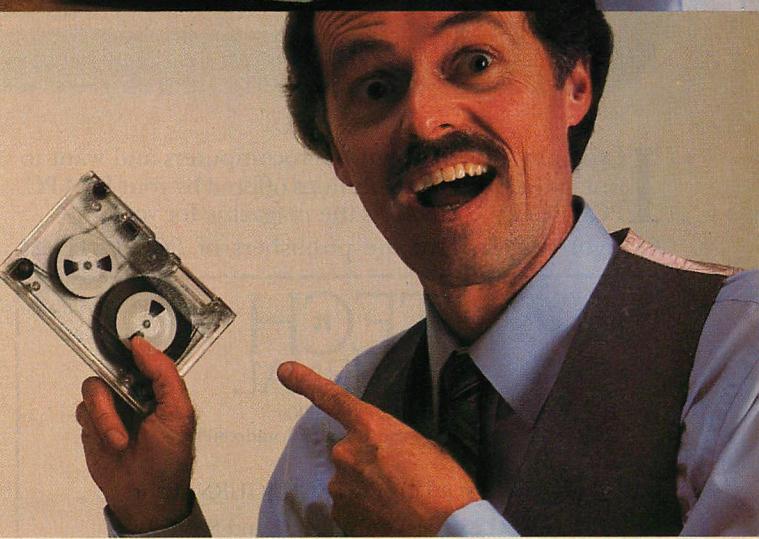
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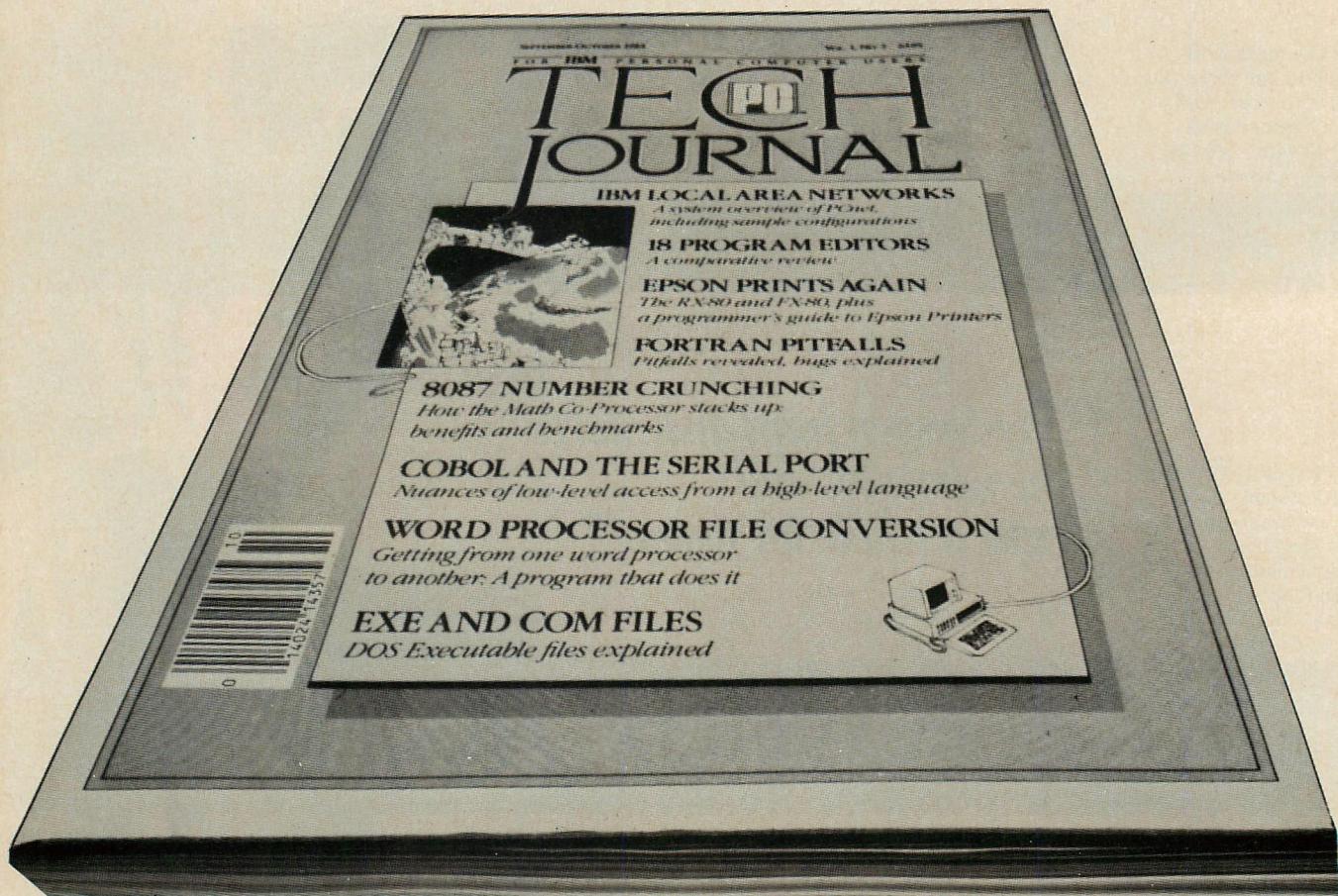


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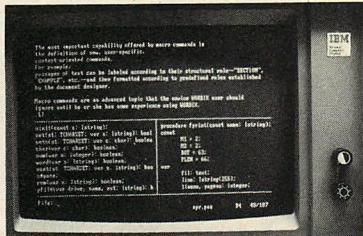
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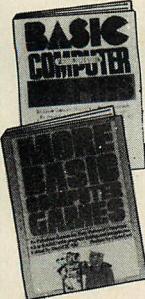
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<b>Rush svc.</b>	yes	yes	yes	no	yes	yes	yes	yes
<b>Copy all popular formats</b>	yes	yes	yes	n/a	yes	yes	yes	yes
<b>Downloading to/from</b>	CPM only	most exc. Apple, Commodore	most	n/a	no	no	no	n/a
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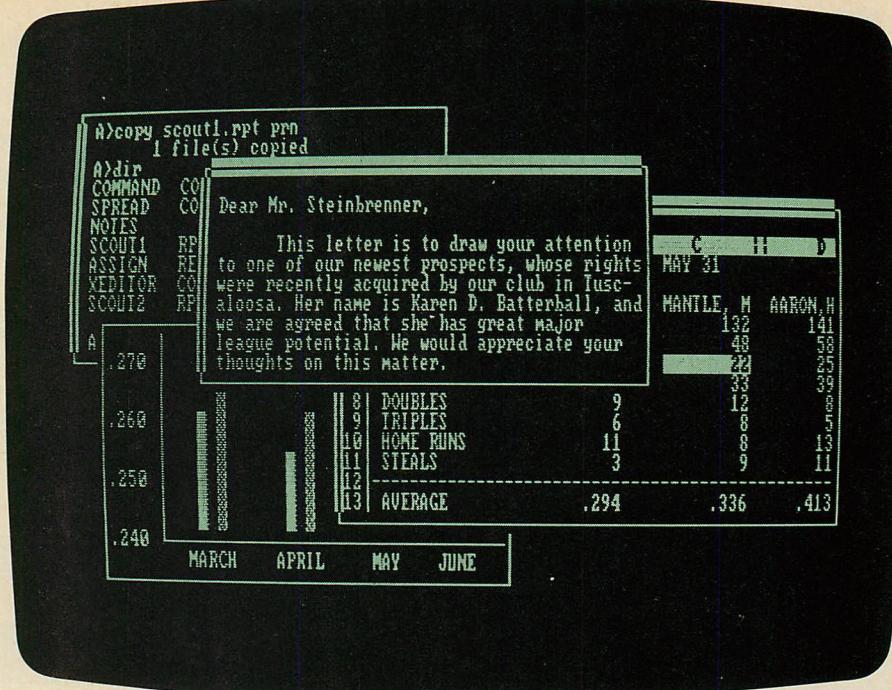
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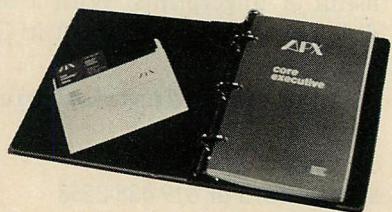
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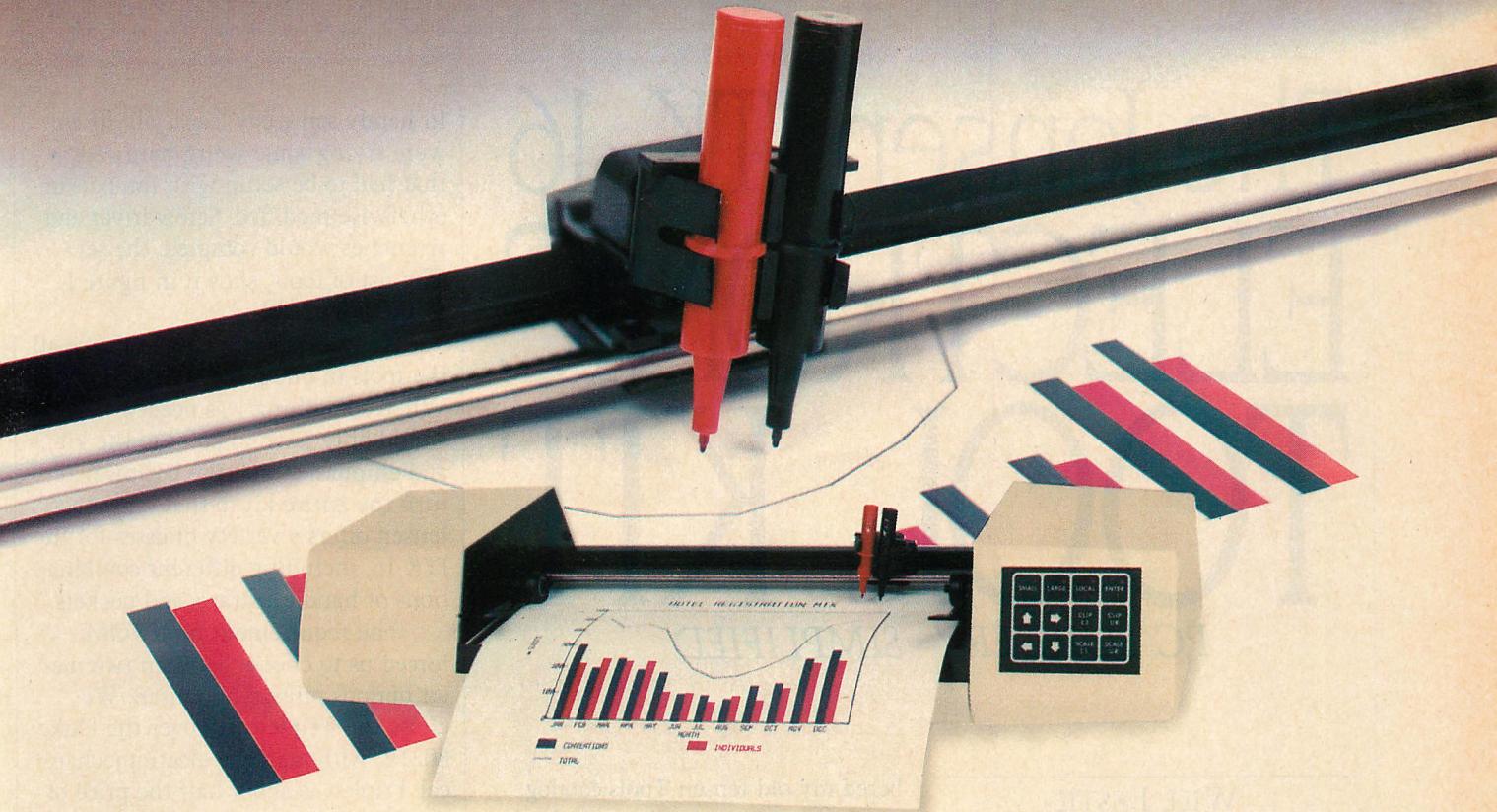
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# The Jensen JTK-16 ELECTRONIC TOOL KIT

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The owners of IBM PCs fall into two categories: those who will never open the case, connect any wires, or otherwise attempt to maintain the equipment, and those who will.

When we opened the editorial office for *PC Tech Journal*, we knew full well that we would be inside our PCs all the time, for many reasons. It was likely that we would assemble our units when they came or at the very least insert an option not purchased with the machine. To test communications products or networks, the systems would have to be reconfigured. It was even probable that we would insert or remove integrated circuits from time to time. And, of course, we would want to perform our own diagnosis of system failures both as a way of understanding more about the computer and to see how effective the IBM documentation and service procedures were during the maintenance process.

When I realized that the office would require tools, my first thought was to run to the local hardware store and pick up a few things. But the list of tools was more than a screwdriver and a pair of pliers; the hardware store was not up to it. Then I remem-

bered my old Jensen Tools catalog.

It was lurking under a stack of dusty papers in my workshop, and it was a year or so out of date. But sure enough, it listed a number of kits that looked promising. I called Jensen to obtain the most current catalog, which arrived promptly in the mail. The new book listed a newer version

**W**hen we opened the editorial office for *PC Tech Journal*, we knew full well that we would be inside our PCs all of the time, for many reasons.

of an inexpensive kit that seemed to include all the tools from my list and then some. It was the JTK-16™ Compact "Detective" Tool Kit, shown in photo 1.

My objective was to purchase a set of professional quality tools that would be suitable for any situation we might encounter. For example, the IBM diagnostics manual lists a volt-ohm-meter (VOM) as a basic requirement for trouble-shooting. I thought a soldering iron might come

in handy some day, especially if we were trying some weird hardware that had to be setup with jumpers or otherwise modified. Screwdriver and wrenches would complete the set. The list of tools, shown in figure 1, fit the bill exactly.

Another objective was to have all the tools in one place, all the time. When something was needed, I would only have to point to the kit and emphasize that the borrower return the *entire* kit to that same spot. Jensen offers a variety of cases for the JTK-16, including different combinations of handles, straps, and pockets.

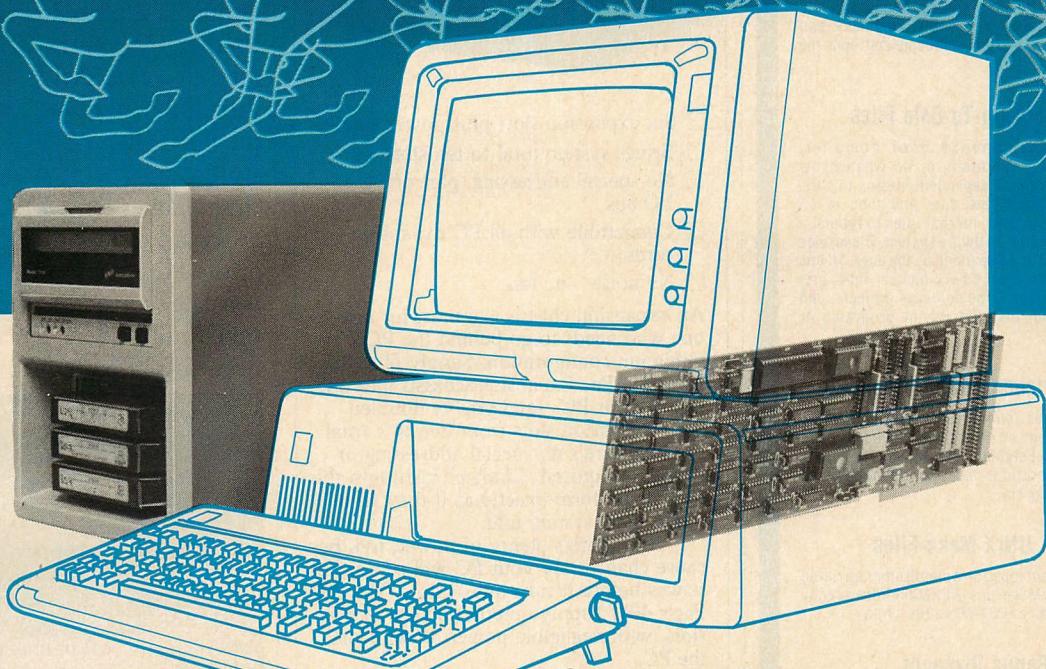
The requirement for a VOM forced us to choose between two meter options offered by Jensen. We chose the Triplett 310 over the Fluke 8021B. Although the electromechanical Triplett is about half the price of the digital Fluke, our choice was driven by the presence of meter drawings in the *IBM Advanced Diagnostics*

**Figure 1:**  
**Tools included with the**  
**JTK-16 (model AP-16L)**

Alignment tool set (two tools)  
Burnisher (for relay contact)  
File, flat needle type  
Knife, precision  
Nutdriver blade,  $\frac{1}{4}$ " stubby  
Nutdriver blade,  $\frac{5}{16}$ " stubby  
Nutdriver blade,  $\frac{3}{8}$ " stubby  
Plastic handle, multi-purpose,  $4\frac{1}{8}$ "  
Plastic handle, multi-purpose,  $3\frac{1}{8}$ "  
Pliers, chain nose,  $4\frac{3}{4}$ "  
Pliers, long-nose side cutting, 6"  
Pliers, diagonal cutters,  $4\frac{1}{4}$ "  
Pliers, utility, 6", opens to 1"  
Rule, 6", stainless  
Saw blade for knife, keyhole type  
Screwdriver blades:  
     $\frac{3}{16}$ " regular,  $\frac{1}{4}$ " regular,  $\frac{5}{16}$ " regular,  
    #1 Phillips, #2 Phillips,  
Screwdriver set, jeweler's type,  
    blades .025" to .1"  
Screwdriver, miniature, #0 Phillips  
Soldering iron  
Solder, 60/40, small coil  
Solder aid, miniature fork and hook  
Wire stripper, with adjustable stop  
Wrench, adjustable, 4", opens to  $1\frac{1}{2}$ "  
Wrench set, Allen hex, 10-piece  
Wrench set, Bristol-spline, 10-piece  
Zipper case (vinyl)

**Note:** IBM PC requires  $\frac{3}{16}$ " and  $\frac{1}{4}$ " nutdrivers. *PC Tech Journal* suggests Jensen's long-stemmed nutdrivers, part numbers AP3B623 and AP3B627, each \$2.75.

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# TOOL KIT

manual. These drawings show the Triplet 310 and include the actual settings to be used.

One thing not included with the kit was a set of integrated circuit insertion and removal tools. This item was quickly found in the Jensen Catalog, and ordered at the same time. Of all the tools ordered, these alone were of below-average quality.

In practice, the tools have worked out very well. Only one thing has caused any difficulty. We thought the nut drivers included with the kit were the correct size for both the IBM chassis screws and the option card fastening screw, which is smaller. This turned out to be incorrect, so we needed an additional nut driver. Furthermore, the nut drivers provided with the JTK-16 are the stubby ones, with stems less than three inches long. I found these very awkward to use in the close quarters of the PC system unit. This problem was later solved by ordering two additional nut drivers, one of each size needed, and both with the long stem.

**Figure 2:  
JTK-16 Prices and Options**

Jensen Catalog#	Item	Price
AR-16L	Kit, vinyl case	\$139
AR-16LH	Kit, vinyl case with handles	\$144
AR-16LL	Kit, leather case with handles	\$184
AR-16LS	Kit, vinyl case with strap	\$143
For metric version of above, add "MM" suffix to part numbers and \$5 to price.		
AR56B200	Triplet 310	\$74
AR317B021	Fluke 8021B M	\$159

I recommend that these two nut drivers be ordered at the time of purchase of the kit.

One nice touch is the inclusion of two multi-purpose handles. These handles are used for the screwdrivers and nut drivers, and it is convenient

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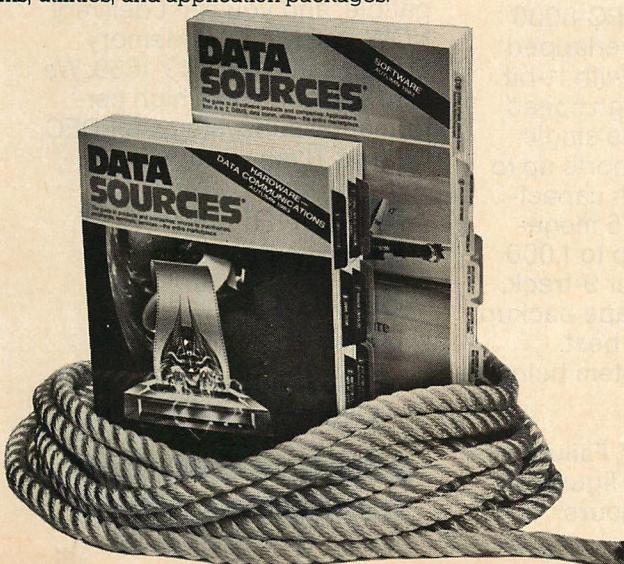
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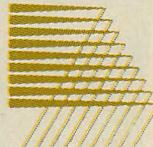
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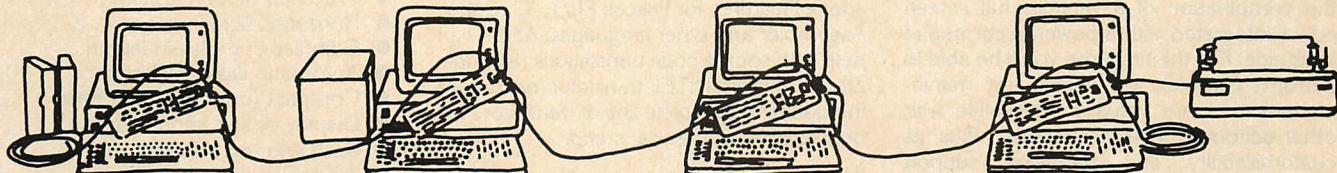
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### ■ How It Works...

Non programmers use Levels I and II.

Level I consists of:

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- A powerful, fast **sort** capability.

Level II consists of:

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Level III — Database modules for programmer use.

### COMPARISON OF POPULAR DATA BASE MANAGEMENT PROGRAMS

	The B.O.S.S.	dBase <sup>TM</sup> II	TIM <sup>TM</sup> III	Condor <sup>TM</sup> 20	Data- Star <sup>TM</sup>
Multi-user network	Yes	No	No	No	No
Menu driven	Yes	No	Yes	Yes	Yes
Files open on line	8	2	N/A	2	1
Maximum records/file	100,000,000	65,600	32,800	32,800	32,800
Maximum bytes/record	10,000	1,000	2,400	1,000	255
User must be programmer	No	Yes	No	No	No
Maximum number of indexes automatically updated.	15	1	1	1	1

(Data are taken from most recent versions of programs available to American Planning Corporation, Alexandria, VA)

### ■ Advanced Features

Experienced analysts and programmers use all levels to create sophisticated business application programs.

The B.O.S.S. provides analysts and programmers with a broad and varied set of functions patterned after mainframe software development tools. Large and complex programs are created easily and in record time.

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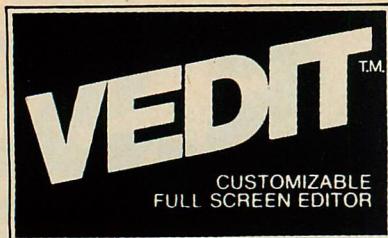
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VEDIT cuts programming time in half - with multiple file handling, macro capability and special features for Pascal, PL/1, 'C', Cobol, Assembler and other languages. And it can help with source code translations (example ZILOG to/from INTEL translator macros are included). A complete line of translators will be available by the year's end.

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# TOOL KIT



The JTK-16. The meter shown is the Fluke 8021b. The Triplett 310-J is also available.

to have two tools ready to work with at the same time. An omission is tweezers, which can be very helpful in small places. Jensen seems to include these only with the bigger tool sets but does offer them as a separate item in the catalog.

Overall, the kit is of high-quality and includes a compact but effective

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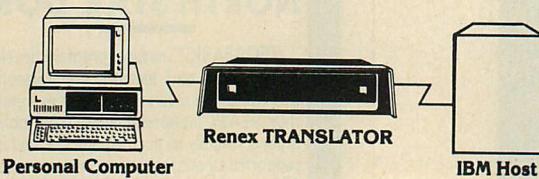
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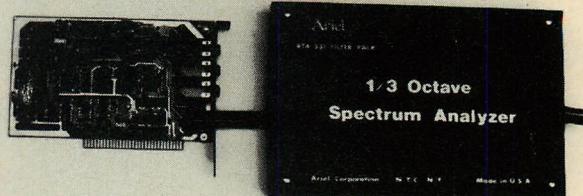


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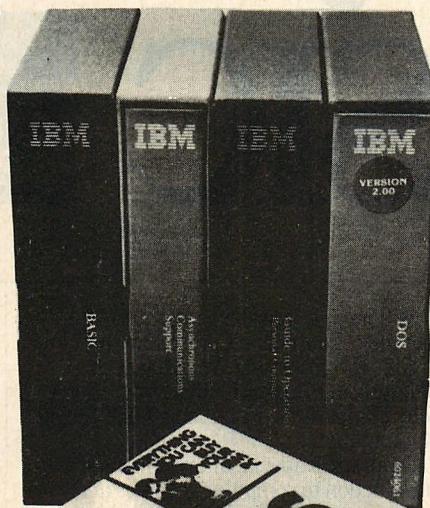
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# V

## IDEO I/O AND GRAPHICS WITH IBM PASCAL

*Controlling video I/O  
using an undocumented  
function provided with  
the Pascal compiler*

---

BARBARA CLINGER

---

**I**t is often desirable to use graphics and color as an integral part of a program that also requires the ability to clear the screen and move the cursor from one position to another. It has long puzzled me that IBM's Pascal by Microsoft apparently does not directly support this combination. In the course of investigating this problem, I discovered that in fact it is possible to control video input and output using an undocumented function in file Pascal.Lib, which is provided

with the Pascal compiler.

Using the search and unassemble commands in DEBUG, I found a file called VIDX6.ASM which uses the assembly language instruction INT 10 (16 in decimal). The function defined in this file is VDOXQQ, it has one argument and uses the variables VRBXQQ, VRCXQQ, and VRDXQQ, which correspond to the BX, CX, and DX data registers respectively. The value of the argument is placed into the AX register when the function is called. Conforming to the notation in

*Barbara Clinger is professor of mathematics at Wheaton College in Norton, MA.*

# VIDEO I/O

the Pascal manual, the definition of the function is:

## FUNCTION VDOXQQ (AX : WORD) : WORD

Briefly, the INT 10H instruction is used to control various aspects of the video monitor, to read and write to the monitor, and to handle video graphics. This interrupt is part of the Basic I/O System (BIOS), and a listing of the relevant portions of the System BIOS VIDEO-IO is given on pages A-47 through A-72 in the *Technical Reference Manual* (#1502234), revised edition (April, 1983). A summary of these commands from the reference manual is given in table 1.

I have found that a simple example can often save me an hour or so of time in learning a new function,

**B**riefly, the INT 10H instruction is used to control various aspects of the video monitor, to read and write to the video monitor, and to handle video graphics.

especially since I do not often use external functions in my programs. Therefore, I have included a complete Pascal program illustrating the use of the function VDOXQQ (see listing 1). The beginning of the program declares the external function and variables, and the rest of the pro-

**Table 1: Commands to Control Video I/O**

### Interrupt 10

FUNCTION NUMBER	FUNCTION	OPTIONS
<b>Video I/O</b>		
(AH)=0	<b>SET MODE</b>	(AL) = mode value = 0 40x25 B & W alphanumerics = 1 40x25 color alphanumerics = 2 80x25 B & W alphanumerics = 3 80x25 color alphanumerics = 4 320x200 color graphics = 5 320x200 B & W graphics = 6 640x200 B & W graphics = 7 80x25 B & W card
(AH) = 1	<b>SET CURSOR TYPE</b>	(CH) = bits 4 - 0 = start line for cursor bits 5 - 7 = 0 (CL) = bits 4 - 0 = end line for cursor bits 5 - 7 = 0
(AH) = 2	<b>SET CURSOR POSITION</b>	(BH) = Page number (0 for graphics modes) (DH, DL) = (row, column) (0, 0) is upper left corner
(AH) = 3	<b>READ CURSOR POSITION</b>	(BH) = Page number On exit: (CH, CL) = cursor mode currently set (DH, DL) = (row, column) of current cursor
(AH) = 4	<b>READ LIGHT PEN POSITION</b>	On exit: (AH) = 0 light pen not down/not triggered = 1 valid light pen value in registers (DH, DL) = (row, column) of light pen position (CH) = raster line (0 - 199) (BX) = pixel column (0 - 319,639)
(AH) = 5	<b>SELECT ACTIVE DISPLAY PAGE</b>	(AL) = page number 0 - 7 for modes 0 and 1 0 - 3 for modes 2 and 3 0 - 3 for modes 2 and 3
(AH) = 6	<b>SCROLL ACTIVE PAGE UP</b>	(AL) = number of lines to be blanked at bottom of window = 0 means blank entire window (BH) = attribute for blank lines (CH, CL) = (row, column) of upper left corner of scroll (DH, DL) = (row, column) of lower right corner of scroll
(AH) = 7	<b>SCROLL ACTIVE PAGE DOWN</b>	(AL) = number of lines to be blanked at top of window = 0 means blank entire window

(Continued on p. 182)

## LISTING 1 USE OF THE FUNCTION VDOXQQ

```
Program Type_Ten Interrupts(input,output);
```

```
{ Barbara Clinger
  Professor of Mathematics
  Wheaton College
  Norton, Mass. 02766
  September 28, 1983 }
```

```
Function vdoxqq (areg: word): word; extern;
Var [extern] vrBxqq, vrCxqq, vrDxqq : word;
```

```
Var
```

```
AX,CX : word;
AH, AL : word;
BH, BL : word;
CH, CL : word;
DH, DL : word;
Display_Page : word;
Answer : char;

Begin
  Display_Page := 0;
  { Enter 80x24 color graphics, text mode }
  AH := 0; AL := 3; { Type 0, Mode 3 }
  AX := vdoxqq(byword(AH,AL));
  { Clear the screen, set background to black, foreground to red }
  AH := 6; AL := 0; { Type 6, AL = 0 clears the screen }
  BH := 66; { attribute, green on red }
```

(Continued on p. 182)

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$M\boxdot N$  — To multiply matrix M by the inverse of matrix N

$M\times M$  — To multiply M by itself

$((1\>A)=A\>A)/A$  — To remove any duplicates from a list of data

$99+25?900$  — To generate 25 different random numbers between 100 and 999

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**Table 1: Commands to Control Video I/O**

(continued from p. 180)

### Character-Handling Routines

(AH) = 8      **READ**

**ATTRIBUTE & CHARACTER AT CURSOR POSITION**

(AH) = 9      **WRITE**

**ATTRIBUTE & CHARACTER AT CURSOR POSITION**

(AH) = 10      **WRITE**

**CHARACTER ONLY AT CURSOR POSITION**

### Graphics Interface

(AH) = 11      **SET COLOR PALETTE**

(AH) = 12      **WRITE DOT**

(AH) = 13      **READ DOT**

### ASCII Teletype Routine for Output

(AH) = 14      **WRITE**

**TELETYPE TO ACTIVE PAGE**

(AH) = 15      **CURRENT VIDEO STATE**  
on exit

**(BH)** = attribute to be used on blank lines  
**(CH, CL)** = (row, column) of upper left corner of scroll  
**(DH, DL)** = (row, column) of lower right corner of scroll

**(BH)** = display page

On exit:

**(AL)** = ASCII value of character read

**(AH)** = attribute of character read

**(AL)** = ASCII value of character to write

**(BH)** = display page

**(BL)** = attribute of character or color of character (graphics)

**(CX)** = count of characters to write

**(AL)** = ASCII value of character to write

**(BH)** = display page

**(CX)** = count of character to write

**(BH)** = palette color ID being set (0 - 127)

**(BL)** = color value to be used with that color ID

**color ID** = 0 selects the background color (0 - 15)

= 1 selects the palette to be used:

0 = green (1)/red (2)/yellow

(3)

1 = cyan (1)/magenta (2)/

white (3)

**(AL)** = color value

**(CX)** = column number

**(DX)** = row number

**(AL)** = returns the dot read

**(CX)** = column number

**(DX)** = row number

**(AL)** = ASCII value of character to write

**(BL)** = foreground color in graphics mode

**(AL)** = current video mode

**(AH)** = number of character columns on screen

**(BH)** = current active display page

(continued from p. 180)

```
CH := 0; CL := 0; { row, col of upper left corner to scroll }
DH := 24; DL := 79; { row, col of lower right corner to scroll }
```

```
vrBXqq := byword(BH,0);
```

```
vrCXqq := byword(CH,CL);
```

```
vrDXqq := byword(DH,DL);
```

```
AX := vdoxqq(byword(AH,AL));
```

```
{ place the cursor in row 12, column 39 }
```

```
AH := 2; { Type 2 }
```

```
BH := Display_Page;
```

```
DH := 12; DL := 39;
```

```
vrBXqq := byword(BH,BL);
```

```
vrDXqq := byword(DH,DL);
```

```
AX := vdoxqq(byword(AH,0));
```

```
{ Write six A's }
```

```
AH := 9; AL := 65; { Type 9, A is ASCII 65 }
```

```
BH := Display_Page; BL := 30; { 30 produces bright yellow on blue }
```

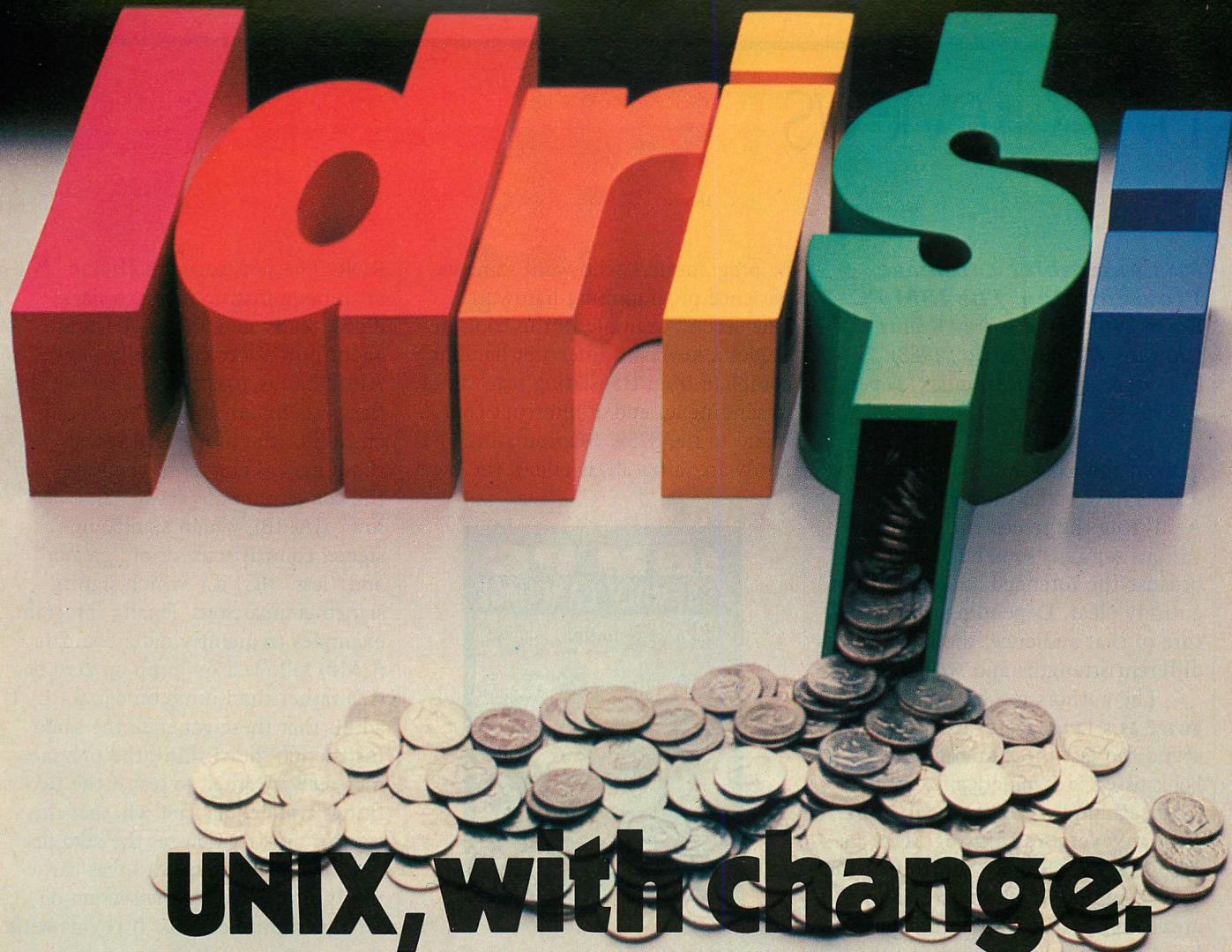
```
CX := 6;
vrBXqq := byword(BH,BL);
vrCXqq := CX;
AX := vdoxqq(byword(AH,AL));
{ Read current cursor position }
AH := 3; { Type 3 }
BH := Display_Page;
vrBXqq := byword(BH,0);
AX := vdoxqq(byword(AH,0));
writeln;
DH := vrDXqq DIV 256; DL := vrDXqq MOD 256;
writeln(DH:6,DL:6);
writeln;
Write('Enter a character '); readin(answer);
{ Return to 80x25 black and white alphanumerics }
AX := vdoxqq(byword(0,2));
End.
```

**T**he technique shown in the Pascal program is used here as an example.

gram, which is less important, performs the following tasks:

1. puts the video display into mode 3 (80x25 color alphanumerics)
2. clears the screen and sets the color to a red background with green letters
3. places the cursor in row 12, column 39 of the video monitor and prints the character A six times beginning at that position on the screen (with yellow letters on a blue background)
4. reads the current cursor position and prints the row and column of its position
5. sets the display back to mode 2, 80x25 black-and-white alphanumerics mode

The techniques shown in this example should add a measure of flexibility to programming with IBM Pascal—flexibility that will be appreciated by anyone trying to use graphics and color in their programs.



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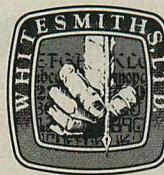
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# Book Reviews

## **8088 Assembler Language Programming: The IBM PC**

*David Willen and Jeffrey Krantz (Howard W. Sams & Co., 1983)  
235 pages, appendices, index, paper, \$15.95*

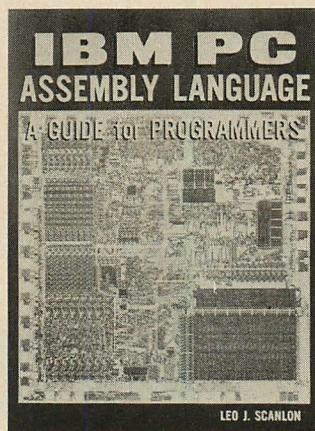
I liked this book a lot, although it does have some shortcomings. Analyzing the treatment given to various topics is somewhat difficult because the intended audience is not entirely clear. Depending on the nature of that audience, the book has different strengths and weaknesses.

The authors teach assembly language as a language to read and then spend the last three-quarters of the book using it in practical examples. These examples aren't trivial, either; they are exercises in using BIOS, using DOS, and directly controlling the most common PC hardware. The areas explored include interrupt handlers for the keyboard and the timers; direct handling of the monochrome, color/graphic, and printer adapters; and disk I/O through both the BIOS and DOS. There is also an excellent discussion of serial communication. But at what level is this information directed?

One possible audience is programmers who have experience in, say, BASIC and want to explore a little. To help them, the book describes the instructions according to what they do (for example, MOV moves a word or byte of data) with no mention of how the instructions are encoded. The advantage of this is that the examples are easy to read, containing no distractions (none of the program listings have the hex values of instructions). The disadvantage is that the reader is not really made aware of some of the restrictions that the examples sidestep (for example, the command MOV DS,ES is not a legal instruction).

Another possible audience might

be programmers who want some experience programming hardware. The second example in the book includes a keyboard interrupt handler complete from translating scan codes to sending an end-of-interrupt command to the 8259. Manipulating hardware, after all, is one of the big



attractions of going to assembly language. Seeing these examples in print takes away a lot of the mystery.

Still another audience is those people who were overwhelmed by the detail in IBM's *Technical Reference* manual and macro assembler manual and who want only some of the essentials and a couple of real examples to stare at. Leaving out details that are unnecessary for reading programs is the key to this book. Program layout (setting up the stack and other segment(s)) is described once, from then on all the examples use this layout in a cookbook fashion. One result of this is that the authors, by choosing the options for you, make the 8088 look much more reasonable than it really is.

One complaint I have about this book is that the discussion of conditional jumps is too brief. This subject has always been a problem for me when reading assembly language. The first test in the first program example was SUB AL, 'O' then JC ER-

ROR! The four-page description of arithmetic instructions and flags didn't really give me a good hint about how subtract sets the carry. Also, the discussion about setting the flags was fifteen pages from the discussion of the jumps that tested those flags. There is no mention of the convention of "above" and "below" (JA, JB), which signify unsigned comparisons, or of "greater" and "less" (JG, JL), which signify signed comparisons. Finally, program examples frequently did a compare (CMP) followed by jump on zero flag (JZ) rather than jump on equal (JE). I admit that these generate the same instruction, but I think the programmer really wanted to test if the two things were equal, not whether the compare instruction set the zero flag.

On the other hand, I was particularly impressed by the section on serial communications. It begins with the sentence, "Before we explore how to control the communications adapter, a complete background on serial communications is presented." This promises a lot, and, at least for me, it delivers. In ten pages they summarize just what I want to know about baud rates, start bits, stop bits, parity, modem control signals, UARTs, and RS232. I showed this section to all my friends.

This book is definitely not the only book you will ever need to learn assembly language (among other things there is no mention of instructions such as LEA—load effective address—or AAA—ascii adjust for addition). Nor is this the only book you will ever need to use DOS or the BIOS (while it tells you how to open a file and read the directory, it never mentions how to delete a file or what the directory contains beyond the file name). However, this is definitely a good book for getting your feet wet. ■■■

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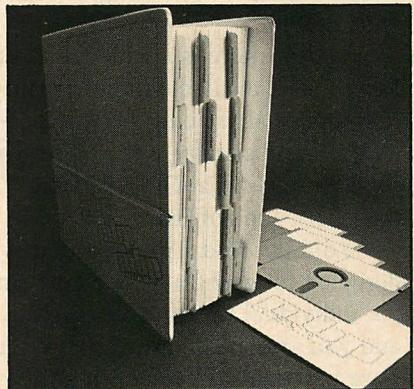
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# Taxes by the PC

Three software packages designed primarily for the professional tax planner:  
Cal-Q-Tax, Micro-Tax (Level II), and SofTax

## MAX STUL OPPENHEIMER

In 1934, Circuit Court Judge Learned Hand wrote "there is not even a patriotic duty to increase one's taxes." The United States Supreme Court affirmed (*Helvering v. Gregory*, 69 F.2d 809, 810 [2d Cir. 1934], aff'd sub nom. *Gregory v. Helvering*, 293 U.S. 465 [1935]).

Today, there is a wide variety of PC software available to help maintain a razor-sharp edge between patriotism and charity. I reviewed three such packages: Cal-Q-Tax, Micro-Tax (Level II), and SofTax.

I did not find a package that is designed for doing a last-minute simple individual return. If it is April 14 and you are reading this article in the hope of finding an eleventh-hour miracle, stop right now and pick up a copy of IRS Form 4868 (*Application for Automatic Extension of Time to File U.S. Individual Income Tax Return*) and follow the instructions.

Then buy a hand calculator or a spreadsheet program, both of which will have some residual value after the return has been prepared. April, 1984 is really the wrong time of year to begin thinking about doing anything with your 1983 tax returns except filling out the forms. About the only tax planning that can still be done is opening an IRA (Individual

Retirement Account).

Although all three packages have much to recommend them and are to some extent menu-driven, they are really not designed for the casual user (nor do they purport to be):

1) They cannot take the place of a tax professional—they calculate accurately, but they do not give advice or spot alternatives.

2) They are expensive considering that their use is quite limited.

**Table 1: Key Features of Cal-Q-Tax, Micro-Tax, and SofTax**

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Micro-Tax® (Level II)	\$1,000 initially Annual revisions, \$350	96K 1 drive	Ready-to-file	1¾ hrs	Microcomputer Tax Systems, Inc. 6203 Variel Ave. Suite A Woodland Hills, CA 91367 213-704-7800
SofTax®	\$199	VisiCalc® 2 drives 64K	Ready-to-file	1¼ hrs	Design Trends P.O. Box G Wilton, CT 06897 203-834-1560
Hand calculator	\$8	—	8-digit LED	2 hrs	—

\*All packages were used to calculate the same return, consisting of six forms. Time reported is from the time the machine was turned on until the tax was calculated—it does not include the time to read the manual. Use for comparison only—your mileage may vary.

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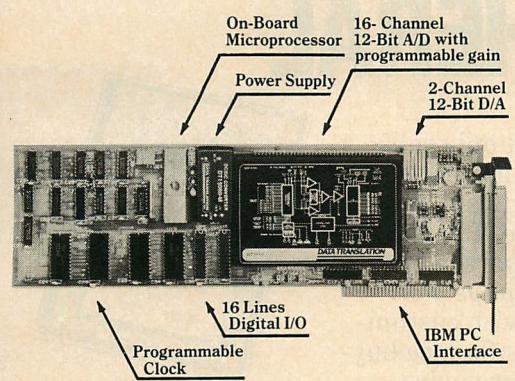
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# Legal Brief

Bearing in mind that the tax law and tax rates change every year, the cost of these packages must be justified solely on the basis of their value this year—you will have to buy a new package (or at least an update) to do next year's taxes. In that context, even the least expensive package is not cheap, unless you plan to share

the cost of the package by reselling it once you have done your own taxes.

3) To become familiar with them requires enough time that a simple return can be prepared more quickly using a calculator and pen.

## INDIVIDUAL REVIEWS

**Cal-Q-Tax.** Cal-Q-Tax is strictly a

professional tax-planning tool, and a slick one. Its I/O does not even vaguely resemble a Form 1040. For example, if you have dividend income from more than one company, you must calculate and enter the sum rather than the individual payments.

The display is three-tiered: there are a main worksheet, sub-worksheets, and help screens. Data can be entered directly on the main worksheet, where the tax is calculated. When additional detail is required, subworksheets are accessed. Pressing W when the cursor is on the "Ordinary Income" line of the main worksheet produces

Wages

Self-Employment Income

1231 Ordinary Loss

Other Ordinary Income

Data entered here will be summed and the result displayed on the "Ordinary Income" line of the main worksheet.

Hold on—what about dividends?

Aren't they ordinary income? Place the cursor on the "Other Ordinary Income" line and type H for Help. The Help screen explains that ordinary income is the total of interest, dividends, and net income from rents, royalties, estates, trusts, partnerships, etc.

Data entry is quick, partly because of the level of abstraction and partly because of the well-designed structure of the package.

The Cal-Q-Tax manual is easy to use, although there was no index when I reviewed this package (one should be available by the time this article is published).

There are advanced-planning features for doing projections for future years and for comparing alternatives simultaneously on-screen.

Cal-Q-Tax's one drawback is its inability to prepare ready-to-file output. Overall, it is an impressive, easy-to-use planning tool.

**Micro-Tax (Level II).** Micro-Tax will produce fileable forms and comes with transparent overlays for Form 1040. It accepts more detail

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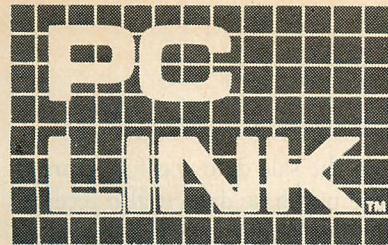
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# Legal Brief

than Cal-Q-Tax but also requires more disk-access. Data entry is menu-driven and requires that a new client disk be initialized (as well as formatted), a new client file created, and schedules selected before any data is entered. Actual data input follows the format used on the IRS forms.

Following data entry, additional

returns to menus are required: "compute tax," "compute all schedules," "calculate tax," and "display recap."

Micro-Tax lacked error trapping in places I would have expected it. It accepted an IRA contribution of \$15,000—far in excess of what the IRS would accept. It accepted an entry under "short-term capital gain" in

which the sale date was five years after the purchase date; it also accepted a sale date prior to the purchase date.

I found the manual difficult to use as a reference: for example, there is no index. I barely averted a menu-driven disaster when, in an effort to delete one schedule, I selected "15 Delete Client Files" (which removes the entire set of forms) instead of selecting "2 Select Schedules and Forms" followed by "2 Delete Schedules" and "4 File the Selected List."

**SofTax.** Of the three packages, SofTax is the closest to being suitable for casual use. It requires VisiCalc, and suffers from some VisiCalc-related problems: for example, under certain circumstances you must hit the recalculate key ("!") seven times to get the correct answer. Other problems are that format restrictions do not allow the screen display to parallel the IRS forms and that you can't enter certain mixed numeric and alpha data (such as "500 shares IBM" as a description of property on Schedule D). On the other hand, SofTax has the advantage that its use is very nearly intuitive if you have used VisiCalc.

Data entry follows essentially the same format used by the IRS forms, with some accommodation for the limited column widths.

SofTax has fewer forms available than either of the other two packages, so be sure it will handle your applications before purchasing it.

## Summary

Table 1 compares key features of these packages. All three products are better suited to the tax professional than to the casual user.



*Max Stul Oppenheimer has an engineering degree from Princeton and a law degree from Harvard. He is a partner at Venable, Baetjer, and Howard in Baltimore.*

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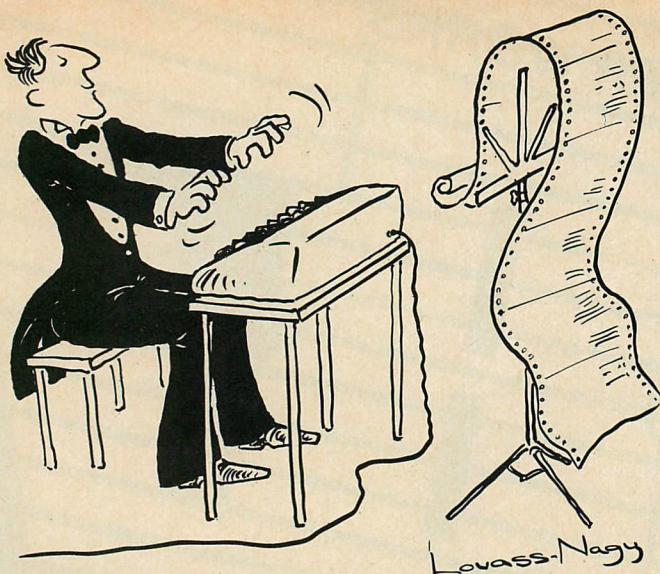
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XASM65	6502		
XASM68	6800/01		
XASMZ8	Z8		
XASMF8	F8/3870		
XASM400	COP400		
XASM75	NEC 7500	\$500.00	
Coming soon: XASM68K...68000			

(Upgrade kits will be available for new PROM types as they are introduced.)

Programmer ..... \$389

Options include:

- Software Driver Package --
- enhanced features, no installation
- required.
- CP/M-80 Version ..... \$ 75
- IBM PC Version ..... \$ 95
- RS 232 Cable ..... \$ 30
- 8748 family socket adaptor ..... \$ 98
- 8751 family socket adaptor ..... \$174
- 8755 family socket adaptor ..... \$135

**G7228 Programmer by GTek** -- baud

- to 2400 ... superfast, adaptive program-
- ming algorithms ... programs 2764 in one
- minute.

• Programmer ..... \$499

• Ask us about Gang and PAL programmers.

**HEXTRAN Universal HEX File Con-**

- verter -- Converts to and from Intel,
- Motorola, MOS Technology, Mostek,
- RCA, Fairchild, Tektronix, Texas
- Instruments and Binary formats.

• Converter, each version ..... \$250

### Call Us

If you're thinking about development systems, call us for some straight talk. If we don't have what you need, we'll help you find out who does. If you like, we'll even talk about Bach.

**CALL TOLL FREE 1-800-448-8500**

(In the U.S. except Alaska and Hawaii)

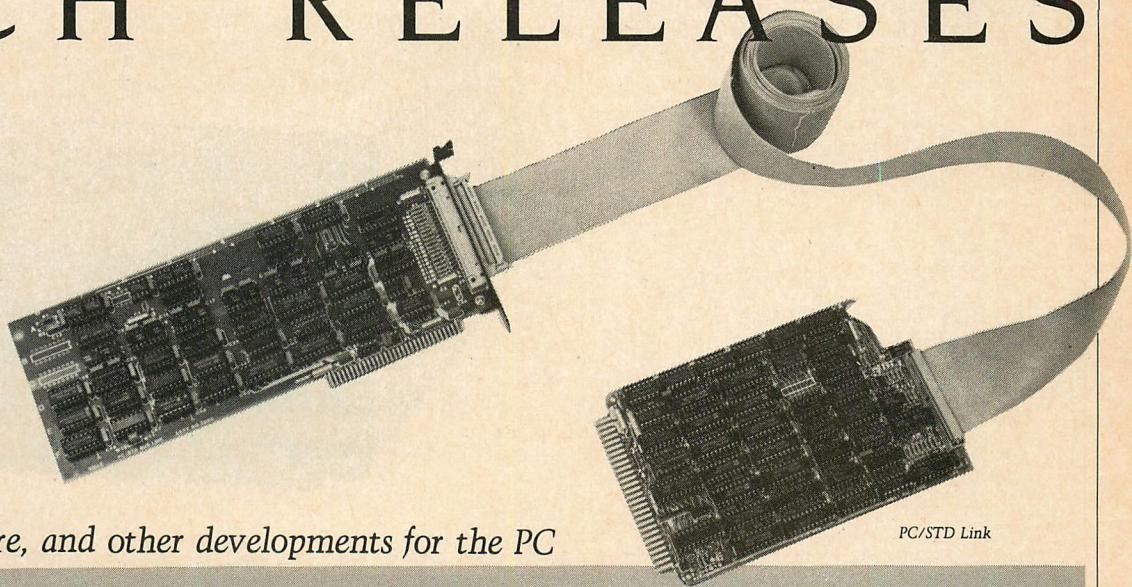
VISA and Mastercard accepted. All popular disc formats now available -- please specify. Prices do not include shipping and handling -- call for exact quotes. OEM INQUIRIES INVITED.

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\*\*Trademark of Microsoft

**AVOCET SYSTEMS INC.™**  
DEPT. 384-PCT  
804 SOUTH STATE STREET  
DOVER, DELAWARE 19901  
302-734-0151 TELEX 467210

# TECH RELEASES



Hardware, software, and other developments for the PC

PC/STD Link

## HARDWARE

**CYB Systems, Inc.** announced two products for the PC: the **Unite 4i PC Network Server System** and the **Unite 16i PC Network Server System**. The 4i allows up to four PC users to share UNIX and MS DOS files, providing all the multi-user, multi-tasking networking capabilities of the UNIX operating system. It is a dual operating system computer/network server that measures 9 by 14 by 15 inches and can be used as a stand-alone IBM PC compatible microcomputer and/or serve as the central node in a network of up to three other PCs, XTs, or existing CRT terminals. The 16i is a desktop or rack-mount unit that can be used as the central node in a network of up to 16 PCs, XTs, and CRT terminals. It has a high-speed microprocessor board and standard features that include one megabyte of floppy disk storage and 96 megabytes of hard disk storage. 4i, \$11,950; 16i, \$39,950.

**CYB SYSTEMS, INC.**  
6448 Highway 290E  
Suite D-106  
Austin, TX 78723  
512-458-3224

CIRCLE 497 ON READER SERVICE CARD

From **Storex** comes the first of its 400 series, compact high-performance 5 1/4-inch mass storage systems for the PC—the **SX410**—with formatted storage capacity of 5 megabytes fixed and 5 megabytes removable. Specifically designed to take advantage of the latest Memorex technology, the SX410 will use the Memorex Minimark rigid disc cartridge. \$3,995.

**STOREX CORPORATION**  
999 Independence Ave.,  
Bldg. E.  
Mountain View, CA 94043  
415-961-1980

CIRCLE 496 ON READER SERVICE CARD



**Winterhalter, Inc.** has introduced its **DataTalker** product line—three communications products for the PC. **DataTalker PC** enables PCs and XT's to emulate seven different IBM terminals and to communicate with IBM mainframes and compatibles. Powered by the micro's processor, DataTalker PC has two serial channels capable of synchronous or asynchronous operation

through either port; will fit any backplane slot in the PC or XT, including the fractional slots; and requires 128K of system memory.

**DataTalker II** is an intelligent front-end processor that plugs into a micro's RS-232 serial port, and, using a choice of included software, the micro emulates several different remote batch and interactive IBM terminal systems. The emulation software is delivered with the DataTalker on system-compatible diskettes, which are then downloaded from the micro to relieve the user system from all communications overhead and overload. DataTalker II is housed in a case measuring 9 x 5 x 3 inches. **DataTalker**

**PC/+** is a smart board designed to allow PCs and XT's to communicate with mainframe computers and communications networks. It is similar to DataTalker II, but requires no cables or independent power supply. DataTalker PC, \$695; DataTalker II, \$995; DataTalker PC/+, \$895.

**WINTERHALTER, INC.**  
3853 Research Park Dr.  
Ann Arbor, MI 48104  
313-682-8834

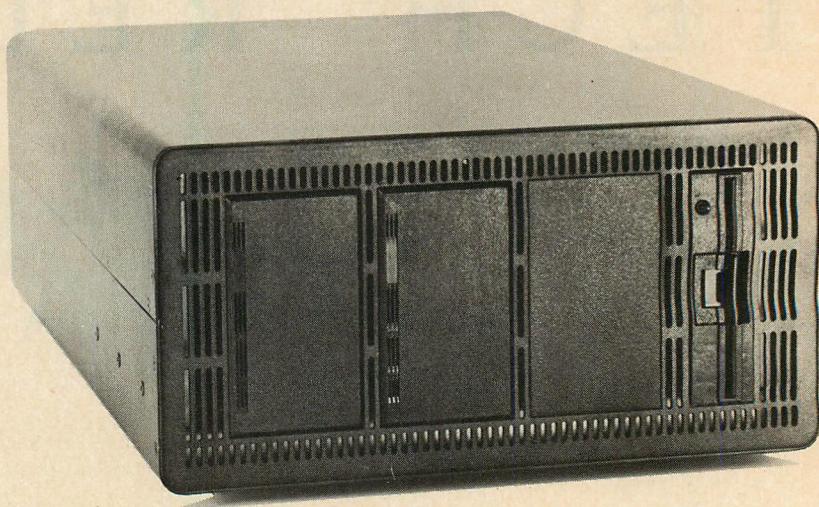
CIRCLE 495 ON READER SERVICE CARD

The **PC/STD Link** and **Mac Pac** from **rmac** are compatible peripherals that link the PC to the widely used STD BUS environment. PC/STD Link consists of two circuit cards linked by a ribbon cable. One card is installed in the PC and the other in any STD BUS enclosure. It serves as an interface and controller between the systems, providing parallel communications with optical isolation and parity checking. The Mac Pac is a companion to the PC/STD Link, designed to hold up to 13 STD BUS cards. \$1,295 each.

**rmac**  
716 Capitola Ave., Ste. G  
Capitola, CA 95010  
408-476-9637

CIRCLE 494 ON READER SERVICE CARD

Four peripheral products have been added to the **IDEAdisk** line for the PC and XT by **IDEAsso- ciates**. The new products are IDEAGraph, a high-speed, high resolution graphics card, IDEAComm 3278, PC-to-mainframe communications, IDEAShare and IDEAnet, resource sharing products, along with the expansion of the IDEAdisk Winchester disk line. IDEAGraph is available in 28MHz and 40MHz versions with 128 or 256k. \$895-\$1,895. IDEAComm 3278 emulates the

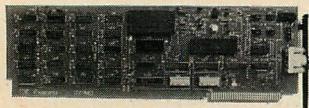


CYB Systems' Unite 16i

IBM 3278 terminal and provides PC-to-mainframe coaxial communications via the IBM 3276 and/or 3274 controller, SNA/SDLC or Bi-sync. \$1,195. IDEAShare is a software product designed for resource sharing among four PCs or XTs within a 100-foot distance. \$595. IDEANet, designed for large-scale networking among 20 or more PCs, is a combined hardware and software product. \$595 for hardware, \$795 for software. Among the new IDEAdisk line is a 10MB IDEAdisk that is internally mounted; others in the line are externally mounted and range in storage capacity from 10MB fixed to 40MB fixed plus 5MB removable. \$2145 to \$5295.

IDEASSOCIATES INC.  
7 Oak Park Dr.  
Bedford, MA 01730  
617-275-4430

CIRCLE 493 ON READER SERVICE CARD



**MicroGate 742** is a Texas Instruments Model 742 emulator from **Gateway Microsystems** that permits PCs to be placed into most 742 polling environments. It is an integrated, single-vendor hardware and software

product featuring the emulation of a compatible subset of the TI Model 742 terminal block mode communications protocol. It is designed for the PC, XT, and the COMPAQ. \$645.

**GATEWAY MICROSYSTEMS INC.**  
9501 Capitol of Texas  
Highway, Suite 105  
Austin, TX 78759  
512-345-7791

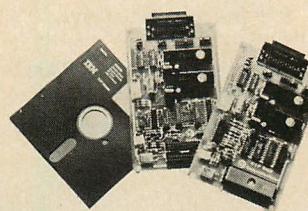
CIRCLE 492 ON READER SERVICE CARD

**Cybernetic Micro Systems** now has a package for converting the PC into an 8748/49 development system. It is a two-part system: the **CYS-8049** software package runs on the PC and provides the cross-assembler and interface routines for the programmer; the **CYP-8049** is an external board (in kit form) that connects to the RS-232 port of any computer and programs the assembled code into the 8748 or 8749. The software package contains a Symbolic Assembler, which takes the standard Intel mnemonics as source code input and generates a listing and Intel format Hex file as output. Source programs may be generated from standard editors available for the PC, including Edlin and WordStar. The ready-to-assemble programmer board will work from

any computer with an RS-232 port but requires appropriate driver software in the host machine. CYS-8049 assembler software, \$195; CYP-8049 programmer board, \$195; \$325 for both.

**CYBERNETIC MICRO SYSTEMS**  
P.O. Box 3000  
San Gregorio, CA 94074  
415-726-3000

CIRCLE 491 ON READER SERVICE CARD



**Alspa Computer Inc.**'s local area network—**Alspa-Net**—is now capable of joining different brands of microcomputers into the same fully interactive network. Interface cards and software have been developed to enable various brand-name computers to become nodes in the network. Alspa-Net is a linear bus network using CSMA/DC protocol; each network supports up to 256 terminals. Interface card and software, \$595.

**ALSPA COMPUTER, INC.**  
477 Division St.  
Campbell, CA 95008  
408-370-3000

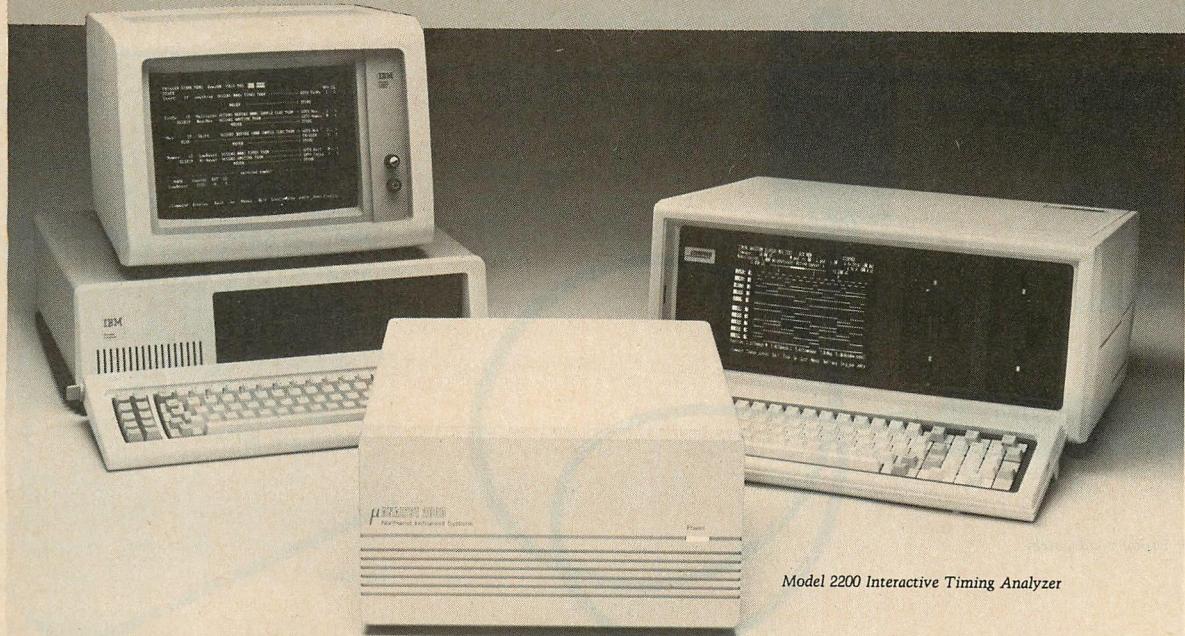
CIRCLE 489 ON READER SERVICE CARD

**Transcryptor** from **Cryptext Corporation** is a security device that blocks unauthorized access to computers and terminals, automatically encrypts messages upon transmission, decrypts upon receipt, and can be configured to provide managerial control over employee access to computers and files. The Z80-based micro has two RS232C ports and stands between a terminal or computer and modem or direct line. Encryption and decryption are automatic, requiring no special operator. \$945.

**CRYPTEXT CORP.**  
P.O. Box 425  
Seattle, WA 98125  
206-364-8585

CIRCLE 488 ON READER SERVICE CARD

The **Program Execution Analyzer (PXA)** is available from **Micro Integrations Engineering Corp.** A single plug-in board with supporting software, the PXA supplies the programmer with a nonintrusive window on code execution. It monitors 31 channels of bus information through the expansion connector, eliminating the attachment of separate leads to each system element. With



Model 2200 Interactive Timing Analyzer

PXA the programmer can gather, display and analyze address and data information relating to stack operations, variable handling, DMA accesses, and system interaction with peripheral devices. \$750.

MICRO INTEGRATIONS  
ENGINEERING CORP.  
11 Clearbrook Rd.  
Elmsford, NY 10523  
914-592-8989

CIRCLE 487 ON READER SERVICE CARD

#### Northwest Instrument Systems, Inc. has announced the Model 2200 Interactive Timing

**Analyzer (ITA)** for pinpointing faults in hardware during design of microprocessor- and microcomputer-based systems. Together with the Model 2100 Interactive State Analyzer, a software debugging and analysis tool, the two products provide an instrument set that covers the full scope of performance requirements during hardware and software integration. The Model 2200 ITA has 16 timing input channels with a maximum of 100MHz sample rate that uses a memory-efficient transitional timing mode. It is implemented on two plug-in cards that are compatible with the card slots found in the Analyst 2000 chassis.

The two-card set plus probes is \$2,995.

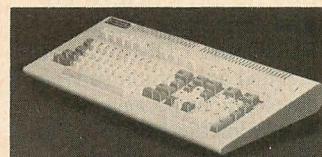
**NORTHWEST INSTRUMENT SYSTEMS, INC.**  
P.O. Box 1309  
Beaverton, OR 97075  
503-297-1434

CIRCLE 486 ON READER SERVICE CARD

**Key Tronic** will make a plug-compatible **keyboard for PCjr**. The KB5151j will come with standard cable connection, and will match Key Tronic's model KB5151, which was also recently announced. It features separate cursor command keys, separate numeric pad, top-row function keys with removable template, and a pencil and book holder ridge. It has familiar key placement and LED status indicators on all lock keys. KB5151, \$255; KB5151j, price to be announced.

**KEY TRONIC CORPORATION**  
P.O. Box 14687  
Spokane, WA 99214  
509-928-8000

CIRCLE 485 ON READER SERVICE CARD



**Ora Electronics** has introduced a fully shielded 25-

pin RS232 to 36-pin parallel **connector cable** assembly. It interfaces with the PC, among other microcomputers, to parallel printers with Centronics/Epson type inputs. The cables feature 25, 24 AWG heavy duty twisted wire, shielded with flexible aluminum and then covered with a durable PVC sleeve. Both the 25 "D" subminiature RS232 pins and the 36 connector pins are gold plated. \$29.95 to \$55.95.

**ORA ELECTRONICS**  
18214 Parthenia St.  
Northridge, CA 91325  
212-701-5848

CIRCLE 484 ON READER SERVICE CARD

The **Enigma Point-to-Point System** from **Isolation Systems** is an integrated hardware/software package that puts the security on the board. The system provides for a network of 64 terminals and thus a potential of 2015 links. Each link is unique, as the DES Encryption key is changed every time data is transmitted. Masterboard, \$1,495; station boards, \$1,395.

**ISOLATION SYSTEMS**  
1631 The Queensway #6  
Toronto, Ontario  
Canada M8Z 5Y4  
416-259-5401

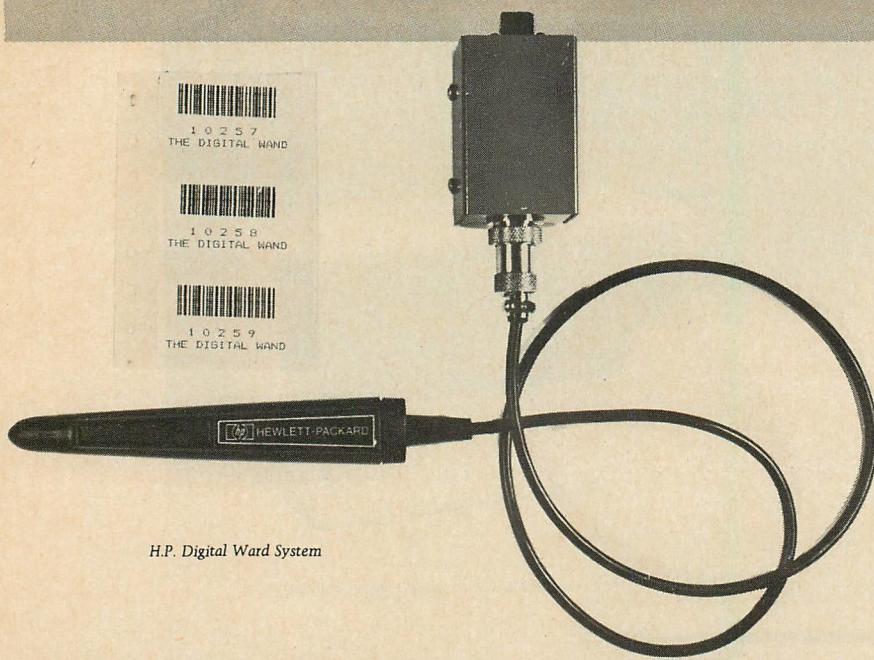
CIRCLE 483 ON READER SERVICE CARD

The **HP Digital Wand System for the PC** from **Computone Data Systems** is a bar code reader/printer package for the PC. It is a hardware/software package consisting of a Hewlett-Packard HEDS-3000 optical wand and a small interface to attach to the DB25 parallel printer socket at the rear of the PC. Three bar code formats are supported in the form of decoder/printer software modules: CODEABAR (numeric), CODE-39 (alphanumeric), and UPC-A (numeric, grocery industry use). The decoder software resides on the PC and links with Microsoft's MBASIC, the basic compiler BASCOM and dBase II. Wand and interface, \$119.95.

**COMPUTONE DATA SYSTEMS**  
1532 Elbridge St.  
Philadelphia, PA 19149  
215-744-5582

CIRCLE 482 ON READER SERVICE CARD

**XTender** is a multi-terminal processing system for the IBM XT from **PC Technologies Inc.** The system integrates all of the XT's system components into a unified process by allowing a single user XT to act as a host central processing unit for up to five concurrent terminals and keyboards. The XTender comes in both



H.P. Digital Wand System

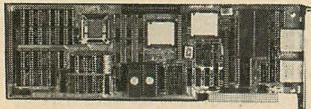


TK! Solver

512K- and 1-megabyte versions and has four serial ports. It is packaged as a circuit board and floppy disk for easy installation. \$3,995.

**PC TECHNOLOGIES INC.**  
P.O. Box 2090  
Ann Arbor, MI 48106  
313-996-9690

CIRCLE 481 ON READER SERVICE CARD



## SOFTWARE

**Verticom Inc.** has announced **Frame Editor**, a new NAPLPS-compatible page-creation software package intended for use with Verticom's PLP200 color graphics terminal. Frame Editor is designed for use with a digitizing tablet or optical mouse; the software allows nonprogrammers to interactively create free-form graphic designs. \$500 to \$2,000, depending on host computer.

**VERTICOM INC.**  
545 Weddell Drive  
Sunnyvale, CA 94089  
408-747-1222

CIRCLE 480 ON READER SERVICE CARD

**Graphic Software Systems Inc.** has two new software families that expand

the graphics capabilities of microcomputer systems. These products will be supplied to original equipment manufacturers and independent software vendors. **GSS Toolkit**, a collection of utilities and subroutines for programming in FORTRAN, Pascal, Compiler BASIC, and C, consists of three products: the **GSS-Toolkit Plotting System**, the **GSS-Toolkit Kernel System**, and the **GSS-Toolkit Window Manager**. The GSS-Toolkit Plotting System is a subroutine library that lets programmers create charts, including bar charts, pie charts, and scatter plots, by manipulating such high-level graphics elements as titles, axes, and legends in addition to color, position, etc. The GSS-Toolkit Kernel System is a programming library that addresses lower-level graphics primitives and is intended for experienced graphics programmers. The Window Manager allows the user to create screen "windows" if desired.

**GSS-Solution** consists of two products: **GSS-Chart** and **GSS-Terminal**. GSS-Chart is used to construct and modify charts and diagrams via displayed symbols and any input device (such as a mouse or other pointer device). GSS-Ter-

minal enables a micro-computer to emulate the Tektronix 4010 family of black-and-white graphics terminals, as well as the Lear-Siegler ADM-3A and similar alphanumeric terminals.

Prices for these products vary according to volume.

**Graphic Software Systems** has also announced that **Lattice** will be distributing ANSI standards-based graphics software from GSS as the preferred extension to the Lattice product family.

**GRAPHIC SOFTWARE SYSTEMS, INC.**  
P.O. Box 673  
25117 S. W. Parkway  
Wilsonville, OR 97070  
503-682-1606

CIRCLE 479 ON READER SERVICE CARD

**LATTICE, INC.**  
P.O. Box 3072  
Glen Ellyn, IL 60138  
312-858-7950

CIRCLE 478 ON READER SERVICE CARD

**PERSONAL COBOL** is now available to qualified IBM PC users. **Micro Focus** announced recently. PERSONAL COBOL is an integrated application software development package designed for the IBM PC. The product will be available through regular retail distribution channels beginning in the second quarter of

1984. Introductory price—\$299. Regular price—\$399.

**MICRO FOCUS**  
1601 Civic Center Drive  
Santa Clara, CA 95050  
408-496-0176

CIRCLE 477 ON READER SERVICE CARD

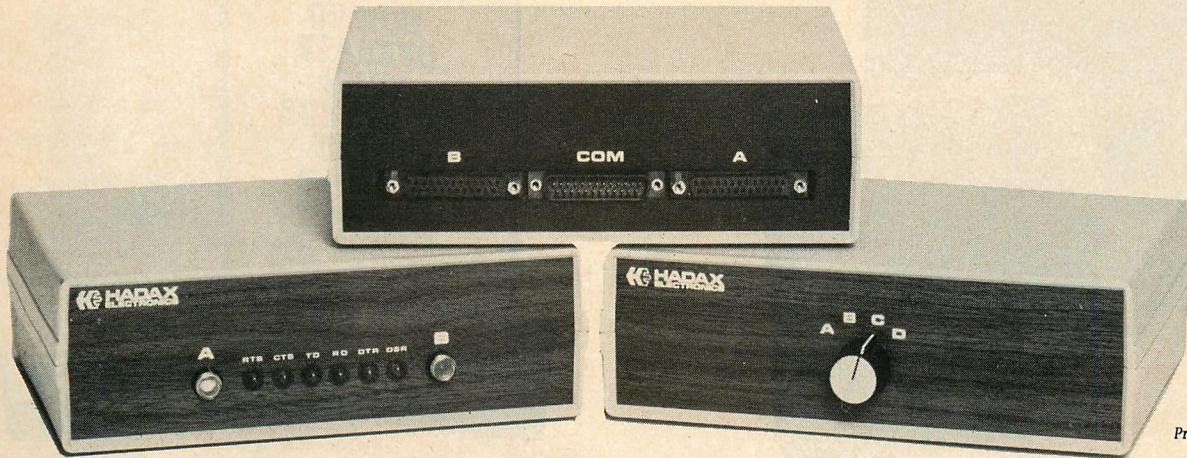
An **MS-DOS version of the TK!Solver** program from **Software Arts** has been announced. TK!Solver features a back-solving capability that allows the user to solve for any of the variables in an equation without reformatting the problem. \$399.

**SOFTWARE ARTS**  
27 Mica Lane  
Wellesley, MA 02181  
617-237-4000

CIRCLE 476 ON READER SERVICE CARD

**Context Management Systems** has introduced **Corporate MBA**, a fully integrated software product designed for large corporations, and an **MS-DOS version of Context MBA**.

Corporate MBA features IBM 3270 terminal emulation and 3270 communications protocols that allow users to link PCs directly with IBM databases. Also included are a data-exchange facility and a macro-command facility. The program runs on MS-DOS. Context MBA allows a user to capture data from a company's information re-



Pro-Comm

sources or from an outside commercial database, reduce and analyze it, present it graphically or textually, and communicate it to others. A self-running tutorial disk is included with both Corporate MBA and Context MBA. Corporate MBA — \$695. Context MBA — \$895.

CONTEXT MANAGEMENT SYSTEMS  
23868 Hawthorne Blvd.  
Torrance, CA 90505  
213-378-8277

CIRCLE 475 ON READER SERVICE CARD

**Insight Window Designer**, a human-factors interface for the p-System which includes windowing capability and enhancements for multi-application integration, was recently introduced by **SofTech Microsystems, Inc.** This machine-independent library includes routines that provide a standard interface for integrating applications, sharing data, and managing system resources. \$150.

SOFTECH MICROSYSTEMS, INC.  
16885 West Bernardo Drive  
San Diego, CA 92127  
619-451-1230

CIRCLE 465 ON READER SERVICE CARD

**Alpha Computer Service** has announced its new

software, **FORLIB-PLUS**, which contains three assembly coded libraries plus support, FORTRAN-coded subroutines, and demo programs. The system requires an IBM PC or equivalent with 192k of memory, one double-sided disk drive, and the Microsoft FORTRAN compiler, version 3.1, or the IBM FORTRAN compiler. \$69.95.

ALPHA COMPUTER SERVICE  
P.O. Box 2517  
Cypress, CA 90630  
714-894-6808

CIRCLE 464 ON READER SERVICE CARD

**PRO-COMM**, a new line of manual switches for use in professional data communications systems, has been announced by **HADAX Products, Inc.** The new line includes two-, three-, and four-way switches for the D-25 connector-based RS-232 interface with 96 different switch configurations. \$85 for a basic 12-lead AB switch, \$25 additional for each monitor port or monitor light option. \$150 for a basic ABCD/four-way switch. Dealer discounts available.

HADAX PRODUCTS, INC.  
79 Hazel Street  
Glen Cove, NY 11542  
516-676-3386

CIRCLE 463 ON READER SERVICE CARD

**Bluebird Systems** has announced that its **SuperDOS operating system and business applications software run on the IBM PC and PC/XT**, expanding the micros into multi-user systems at a cost that is 40 to 60 percent less than comparable local area network systems. SuperDOS will allow up to ten terminals to be linked to the PC and will allow MS/DOS programs to run concurrently with SuperDOS programs. \$10,000 for a three-terminal system including SuperDOS systems software and add-on board with serial and parallel ports, real-time clock/calendar, and 356k of memory. About \$2,500 for SuperDOS and the add-on board alone.

BLUEBIRD SYSTEMS  
6352 Corte Del Abeto  
Suite A  
Carlsbad, CA 92008  
619-438-2220

CIRCLE 462 ON READER SERVICE CARD

**Applied i** has announced the **IBM-PC version of TUTSIM**, a computer simulation program originally developed for microcomputers. Also announced was the availability of TUTSIM demonstration kits that include a diskette and manual. The interactive TUTSIM program is an engineering design tool

and teaching aid that models such complex continuous systems as electronic circuits, chemical reactions, economic models, and the human heartbeat. Results are displayed graphically or numerically. The program allows users to solve problems by constructing and operating a block-diagram simulation of the system and evaluating the results. The IBM-PC version requires a minimum of 64k RAM for graphics output. \$425 in single-unit quantities. Demonstration diskette and manual. \$18.75.

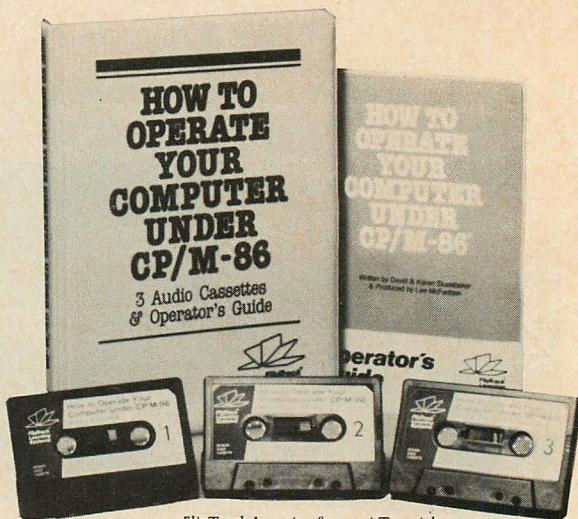
APPLIED I  
200 California Avenue  
Suite 205  
Palo Alto, CA 94306  
415-325-4800

CIRCLE 461 ON READER SERVICE CARD

**RM/FORTRAN**, a high-optimizing, full-level ANSI 77 FORTRAN compiler with extensions, is now available from **Ryan-McFarland**. The compiler is intended for use with 68000-based machines running UNIX-derived operating systems. It runs under Microsoft's XENIX and Unisys' Uni-Plus+ operating systems on Apple Computer's Lisa; systems running on another major 68000-based computer are expected to be announced soon. High-optimi-



Integrated-6



FlipTrack Learning Systems' Tutorial

zation features, which boost program execution speed, include common subexpression elimination, constant propagation, constant expression evaluation, invariant code motion, and strength reduction. RM/FORTRAN supports IEEE floating-point arithmetic. \$1250.

RYAN-MCFARLAND CORP.  
609 Deep Valley Drive  
Rolling Hills Estates, CA  
90274  
213-541-4828

CIRCLE 460 ON READER SERVICE CARD

**Harvard Softworks** has introduced an improved version of FORTH, a program-development system. **HS/FORTH** supports full use of the memory space of the IBM PC and related machines and executes twice as fast as other FORTH systems. It also provides an interactive program-development style, extremely compact code, execution speeds approaching those of assembly language code, and 79-STANDARD plus FIG-FORTH compatibility. \$220.

HARVARD SOFTWORKS  
P.O. Box 339  
Harvard, MA 01451  
617-456-3021

CIRCLE 459 ON READER SERVICE CARD

**4-Point Graphics**, from **IMSI**, is a new, low-cost color graphics program for the IBM PC and compatible microcomputers. It features a four-part cursor and dual memory buffers that allow immediate access to images for comparison, overlaying, and animation. \$195.

INTERNATIONAL MICROCOMPUTER SOFTWARE, INC.  
633 Fifth Avenue  
San Rafael, CA 94901  
415-454-7101

CIRCLE 458 ON READER SERVICE CARD



We've just turned your IBM PC into a graphic design studio! That's right. Starting today, you've got up to 16 dazzling colors at your fingertips, plus the magic of 3D graphics. With 4-POINT GRAPHICS, you can draw anything you like and enlarge it, rotate it, overlay, texture it and zoom in on it.

## OTHER WARES

Two new tutorials are **FlipTrack Learning Systems' six-hour cassette course How to Operate Your Computer Under CP/M-86** (\$75.00) and **Microrim**,

**Inc.'s tutorial for their new R:base® Series 4000 relational database management system for microcomputers** (\$9.95).

FLIPTRACK LEARNING SYSTEMS  
999 Main, Suite 200  
Glen Ellyn, IL 60137  
312-790-1117

CIRCLE 457 ON READER SERVICE CARD

MICRORIM, INC.  
1750 112th Avenue, N.E.  
Bellevue, WA 98004  
800-227-6703  
800-632-7979 (in California)

CIRCLE 456 ON READER SERVICE CARD

**Unisource Software Corp.** has been named the **exclusive U.S. distributor for VENIX/86**, a licensed implementation of AT&T's UNIX Operating System running on the IBM PC. Unisource will offer the VENIX/86 operating system by itself and as part of The Office UNIX System, a package of several business and office applications that run under VENIX/86.

UNISOURCE SOFTWARE CORP.  
71 Bent Street  
Cambridge, MA 02141

CIRCLE 455 ON READER SERVICE CARD

**Microsoft Corp.** has announced that it will drop its

runtime royalty fees for software developers who use Microsoft BASIC, Business BASIC, and COBOL language compilers. Users with signed licenses can contact the company for the new royalty-free agreement. A copyright statement will still be required on all software sold with these routines. Also from Microsoft comes the news that **IBM Instruments Inc.** will provide the **XENIX** operating system for its CS 9000 microcomputer. XENIX is Microsoft's licensed version of AT&T's UNIX operating system.

MICROSOFT CORP.  
10700 Northup Way  
Bellevue, WA 98004  
206-828-8080

CIRCLE 454 ON READER SERVICE CARD

**Mosaic Software, Inc.** has introduced **Integrated-6**, a relational database, presentation-quality business graphics, communications from one IBM PC to another, and terminal emulation to link an IBM PC with a mainframe. It requires 356K memory. \$495.

MOSAIC SOFTWARE  
1972 Massachusetts Ave.  
Cambridge, MA 02140  
617-491-2434

CIRCLE 453 ON READER SERVICE CARD

# TECH BOOK

A Special Section for Product and Service Listings

## ACCESSORIES/SUPPLIES

### IBM PC SECURITY

Deter unauthorized persons from opening PC system unit. Kit includes specially designed Clarke screwdriver & companion Kent screws, kit price \$18.95. Control multiple PC's, qty disc & extra screws available. To order send ck or money order:  
HOOKER TECH/ETERIA  
PO Box 461  
Lawrence, NY 11559

## HARDWARE/ADD-ON BOARDS

### QUADCOLOR VIDEO CARDS

Quadcolor, designed for the IBM PC, has color bit-mapped graphics for sixteen colors on the screen at once. Quadcolor 1 is functionally equivalent to IBM's card and retails for \$295. Quadcolor II offers 640 x 200 high-resolution for \$275. And Quadcolor III offers 640 x 400 high-resolution.

QUADRAM CORP.

An Intelligent Systems Company  
4355 International Blvd.  
Norcross, GA 30093  
(404) 923-6666  
TWX 810-923-6666

### 256K SLOTLESS MEMORY

Let us install up to 256K RAM on your EXISTING SYSTEM BOARD using NO SLOTS. We improve your IBM PC so it can address the 64K RAM chip 128K-\$192, 192K-\$256, 256K-\$320 (expandable and warranted). DO-IT-YOURSELF KITS-PC-KNB-\$39.95, PC-KPC-\$69.95. 64K-PUR-\$5.59 each.  
Add-MEM  
22151 Redwood Rd.  
Castro Valley, CA 94546  
(415) 886-5443

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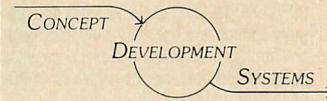
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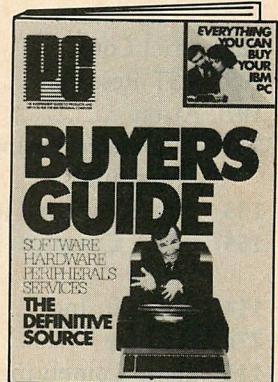
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# INDEX TO ADVERTISERS

READER SERVICE NUMBER	ADVERTISER	PAGE	READER SERVICE NUMBER	ADVERTISER	PAGE	READER SERVICE NUMBER	ADVERTISER	PAGE
273	ABM	47	267	Excalibur	127	184	Per Syst	131
149	ACI Computer Corp.	137	148	Floppy Disc Services	54	162	Personal Computer Userfest	53
153	ADD-MEM	148	105	Greenleaf Software	192	217	Personal Systems Publications	4
226	Alloy Computer Products	133	120	Hauppauge Computer Works	193	185	Phaser Systems	14, 15
227	Alloy Computer Products	135	158	Hayes Microcomputer Products	106, 107	167	Physical Sciences Inc.	161
230	Amdek Corp.	20	151	Hercules Computer Technology	10	268	Polytron	168
104	American High Tech Industries	9	197	Houston Instruments	165	239	Programmer Shop	56
139	American Planning Corp.	171	277	I-Bus Systems	168	190	Pure Data LTD.	62, 63
145	American Planning Corp.	173	223	I.Q. Technologies	143	191	Quadram Corporation	C-2
228	Ann Arbor Software	12	152	IBM	36, 37	194	Quaid Software	114
106	Apparat, Inc.	125	160	Image Processing Systems	176	192	Quantum Software Systems	97
102	Application Executive Corp	164	241	Integral Quality	208	221	Quic-N-Easi Software	145
229	Ariel Corp	174	246	Interphase Corp.	167	125	R & R Software Inc.	101
109	AST Research	17	159	Laboratory Microsystems	114	262	Renex Corp.	174
107	Atron	120	161	Leading Edge	C-4	126	Rixon, Inc.	189
273	Automated Business Machines	47	111	Logitech	128	264	Robert J. Brady Co.	178
103	Avocet Systems Inc.	194	276	M.A. Systems	99	222	Rose Soft	13
155	B & L Computer Consul- tants	161	117	Mansfield Software Group	110	203	Rouge River Software	146
114	Bellesoft, Inc.	35	166	Manx Software Systems	130	Safeware, The Insurance Agency	108	
270	Bizcomp	121	164	Mark Williams Co., The	27	169	Seattle Computer	157
115	Blaise Computing	190	165	MBP Copal	185	265	Seequa Computer Corp.	23
	Borland International	103	269	Metabyte	59	201	Softcraft	122
116	C-Source	52	118	Micro Data Base Systems Inc.	21	199	Softool Systems	110
112	Capitol Equipment Corp.	136	272	Micro Design International	93	280	Software Arts	109
252	Communications Electronics	44, 45	163	Micro Marketing Associates	134	127	Software Link	188
	Compaq Computer Co.	1	324	Microdel	162	142	Software Solutions	117
129	Computer Innovations	26	171	Micromart	90, 91	205	Solution Technology	151
119	Compuview Products	172		Microsoft	55	231	Solution Technology	153
128	Conroy La Pointe	48, 49		Microsoft	57	157	Solveware	140
133	Coosol, Inc.	50	174	Microware	138	207	Strictly Software	188
132	Cosmos	51	193	Microxpress	152	208	STSC	181
121	Creative Solutions	126	204	Multi Tech Systems	8	247	Symtec	41
130	Cuesta Systems Inc.	108	124	Mylestar Electronics	149	232	Sysgen, Inc.	159
210	DCA	6, 7	110	National Memory Systems Corp	170	234	Tall Grass Technologies	2
134	Data Access Corp.	139	186	Northwest Instruments Systems	123	Tall Tree Systems	150	
136	Data Base Decisions	126	179	Optimum Data Processing	134	150	Tecmar	18
251	Data Business Vision, Inc.	141	180	Orchid Technology	24	154	Tecmar	19
202	Data Sources	169	187	Orchid Technology	25	261	Thanks For The Memory	174
137	Data Translation	187	181	Oryx Software	155	235	Transend SSM	122
278	Davong Systems	C-3	274	Paradise Systems, Inc.	95	135	Unisource/Cambridge Digital Supply	30, 31
271	Digital Supply	5		PC Brand	32, 33	113	Vertex	116
279	Disk Tech One	46	182	PC Connection	60, 61	140	Visual Age	124
141	Disk World	156	183	PC Link	191	218	Watsoft Products, Inc.	148
275	Ducan-Atwell	132	122	Pegasus	175	242	Watsoft Products, Inc.	174
147	Dynalysis	58				220	Whitesmiths Ltd.	183
144	Eastern Enterprises	158				108	X-Comp	115
238	Electronic Specialists Inc.	156				243	XOR Corp	111
146	Emerging Technology Consultants	161						

# PC TECH JOURNAL PRODUCT INDEX

RS#	PRODUCT	ADVERTISER	PAGE #
<b>OPERATING SYSTEMS</b>			
192	QNX	Quantum Software Systems	97
135	UNIX Systems	Unisource/Cambridge	30, 31
<b>IBM COMPUTERS AND COMPATIBLE UNITS</b>			
265	Chameleon	Seequa Computer Corp.	23
	Compaq Plus	Compaq Computer Co.	1
152	Personal Computer	IBM	36, 37
161	Leading Edge PC	Leading Edge	C-4
<b>ACCESSORY CARDS</b>			
<b>MULTIFUNCTION BOARDS</b>			
191	QUADBOARD	Quadram Corporation	C-2
273	Superboard	ABM	47
276	I/O Processor	M.A. Systems	99
274	Multi-display Card	Paradise Systems Inc.	95
190	XT Compatible	Pure Data LTD.	62, 63
150	Labmaster	Tecmar	18
154	Problem Solver	Tecmar	19
<b>OTHER ACCESSORY CARDS</b>			
151	Hercules Graphics Card	Hercules Computer Technology	10
126	PC212A	Rixon Inc.	189
324	Realcolor	Microdel	162
107	PC Probe	Atron	120
112	IEEE - 488	Capitol Equipment Corp.	136
186	Analyst 2000	Northwest Instruments Systems	123
247	PGS III	Symtec	41
<b>COMMUNICATION</b>			
204	MT212PC	Multi Tech Systems	8
109	Communications Packages	AST Research	17
235	Communications Packages	Transend SSM	122
184	DCP/88	Per Syst	131
<b>MASS STORAGE HARDWARE</b>			
122	Hard Disk	Pegasus	175
234	Tape Back-up	Tall Grass Technologies	2
230	Disk Drive	Amdek	20
106	Hard Disk sub-system	Apparat Inc.	125
149	ACI Sub-systems	ACI Computer Corp.	137
226	PC Store	Alloy Computer Products	133
227	PC Back-up	Alloy Computer Products	135
279	80 MB Disk Drive	Disk Tech One	46
110	PC-8000 Series	National Memory Systems Corp.	170
232	Back-up Systems	Sysgen, Inc.	159
<b>COMMUNICATIONS HARDWARE</b>			
210	IRMA	DCA	6, 7
158	Smartcom II	Hayes Microcomputer Products	106, 107
108	X-Net	Xcomp	115
104	Supersmart Modem	American High Tech Industries	9
270	PC Intellimodem	Bizcomp	121
278	Multilink	Davong	C-4
<b>ORGANIZATIONS</b>			
162	Insurance	Safeware	108
	Computer Shows	North East Expositions	53
<b>GRAPHICS SOFTWARE</b>			
275	LENIPEN x t	Duncan-Atwell	132
251	GDSS	Data Business Vision, Inc.	141

RS#	PRODUCT	ADVERTISER	PAGE #
<b>SOFTWARE FOR PROFESSIONALS</b>			
103	Cross Assembler	Avocet Systems, Inc.	194
102	APX Core Executive	Application Executive Corp.	164
<b>WORD PROCESSING SOFTWARE</b>			
228	Textra	Ann Arbor Software	12
160	Proofwriter	Image Processing Systems	176
119	Vedit	Compuview Products	172
203	SPF/PC	Rogue River Software	146
<b>LANGUAGES</b>			
164	C Compiler	Mark Williams Co., The	27
241	LISP	Integral Quality	208
208	APL plus/PC System	STSC	181
218	Waterloo	Watsoft	148
242	Interpreters	Watsoft	174
166	Aztec	Manx Software Systems	130
165	Cobol	MBP Cobol	185
116	Turbo Pascal	Borland International	103
129	Basic-C	C-Source	52
159	C86 Compiler	Computer Innovations	26
111	PC/Forth	Laboratory Microsystems	114
	Modula-2/86	Logitech	128
	Microsoft C	Microsoft	57
	Microsoft Pascal	Microsoft	55
<b>PROGRAMMER'S TOOLS</b>			
185	m3278/SPF	Phaser Systems	14, 15
205	Compare II	Solution Technology, Inc.	151
231	Compare II	Solution Technology, Inc.	153
115	View Manager	Blaise Computing, Inc.	190
132	Revelation	Cosmos	51
267	SAVVY PC	Excalibur	127
268	Polylibrarian	Polytron	168
142	DataEase	Software Solutions	117
114	ES/P	Bellesoft, Inc.	35
121	Windows for C	Creative Solutions	126
105	C Library	Greenleaf Software	192
124	Symbolic Debugging Program	Mylestar Electronics	149
280	TK Solver	Software Arts	109
157	SevenWare 8087	Solveware	140
125	ADA	R & R Software Inc.	101
169	RAM + 3	Seattle Computer	157
140	CodeSmith 86	Visual Age	124
134	Dataflex	Data Access Corp.	139
<b>DATA BASE MANAGEMENT SOFTWARE</b>			
139	B.O.S.S.	American Planning Corp.	171
118	MDBS III	Micro Data Base Systems Inc.	21
<b>PRINTERS—PLOTTERS</b>			
197	DMP-40-2	Houston Instruments	165
	Juki	PC Brand	32, 33
<b>ADDITIONAL SUPPLIES</b>			
130	Datasaver	Cuesta Systems, Inc.	108
238	Conditioner	Electronic Specialists, Inc.	156
229	RTA	Ariel Corp.	174
217	Computer manual	Personal Systems Publications	4
264	Books	Robert J. Brady Co.	178
207	Catalogues	Strictly Software	188
202	Books	Data Sources	169
271	Diskettes	Digital Supply	5
223	Smartcable	I. Q. Technologies	143
<b>SOFTWARE UTILITIES</b>			
222	Prokey	Rose Soft	13
113	Xeno-copy	Vertex	116
136	Disks, Manuals	Data Base Decisions	126

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## MARCH

March 12-15  
**Interface '84**  
**Las Vegas, NV**  
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Communications  
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March 22-25  
**West Coast Computer Faire**  
**San Francisco, CA**  
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CA 94063, 415-364-4294

March 26-28  
**7th Intl. Conference on  
Software Engineering**  
**Orlando, FL**  
Sponsors: ACM SIGSOFT, IEEE, Natl.  
Bureau of Standards  
Contact: Robert Fritz, Telesoft, 10639  
Roselle St., San Diego, CA 92121,  
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## APRIL

April 5-7  
**COMDEX/Winter '84**  
**Los Angeles, CA**  
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April 9-12  
**IEEE Infocom 84**  
**San Francisco, CA**  
Sponsors: IEEE-CS, IEEE Communications  
Society

Contact: Judy Estrin, Bridge  
Communications, 10401 Bubb Road,  
Cupertino, CA 95014, 408-446-2981

April 17-19  
**Federal DP EXPO**  
**Washington, D.C.**

Contact: The Interface Group, 300 First  
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April 17-19  
**6th Intl. Symposium on  
Programming**  
**Toulouse, France**

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Recherche Scientifique and Université  
Paul Sabatier de Toulouse  
Contact: B. Robinet, Institut de  
Programmation, 4 Place Jussieu 75230  
Paris Cedex 05, Paris, France

April 23-25  
**Symposium on Practical  
Software Development  
Environments**  
**Pittsburgh, PA**

Sponsors: ACM SIGSOFT and SIGPLAN,  
Natl. Bureau of Standards, Office of  
Naval Research  
Contact: Peter Henderson, Dept. of  
Computer Science, SUNY at Stonybrook,  
NY 11794, 516-246-7090

April 24-27  
**Compdec, Computer Data  
Engineering Conference**  
**Los Angeles, CA**

Contact: Compdec, IEEE Computer  
Society, P.O. Box 639, Silver Spring, MD  
20901

April 30-May 2  
**1984 Symposium on Security and  
Privacy**  
**Oakland, CA**  
Sponsor: Technical Committee on  
Security and Privacy, IEEE  
Contact: Peter S. Tasker, The Mitre Corp.,  
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## MAY

May 13-17  
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National Computer Graphics  
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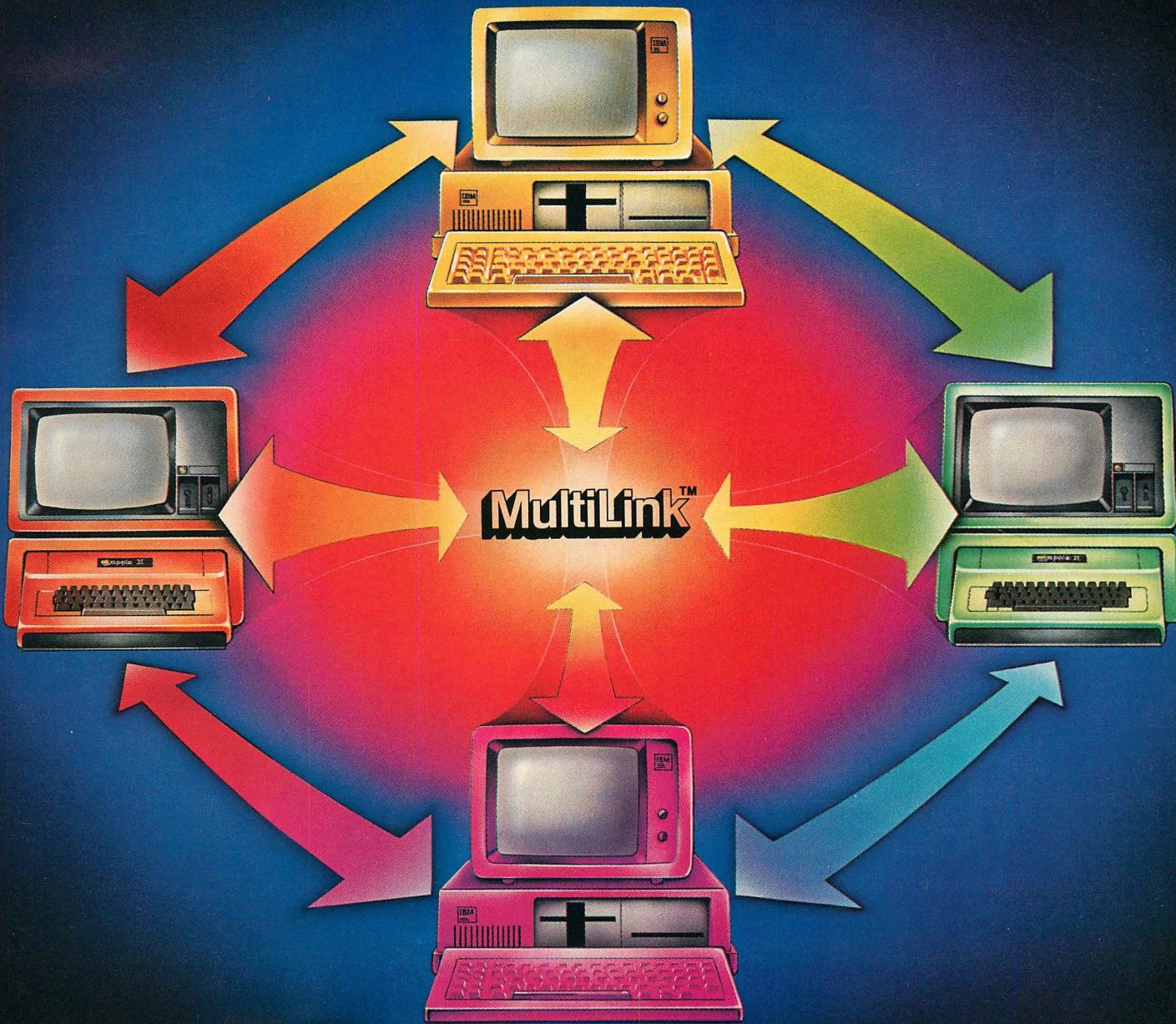
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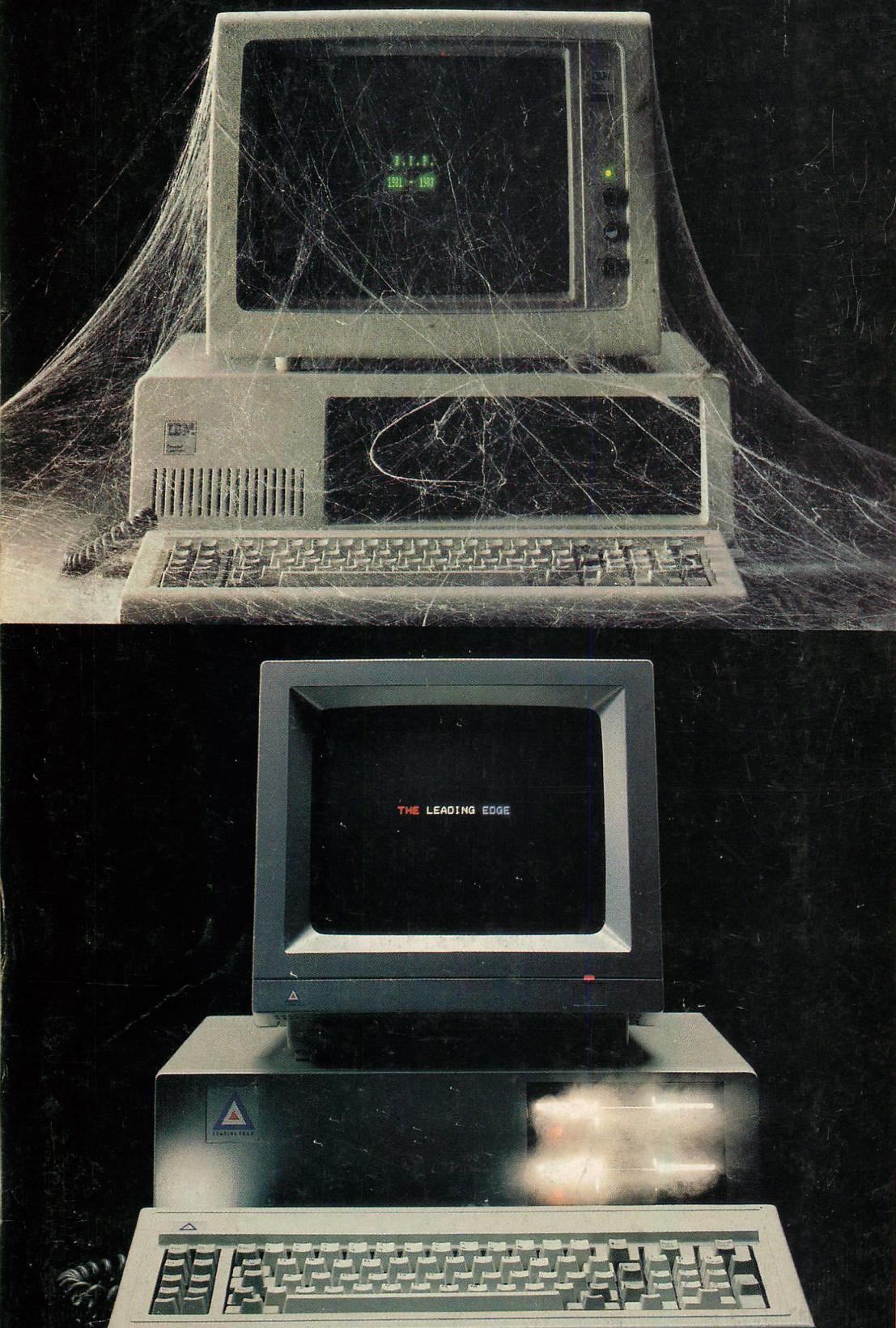


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